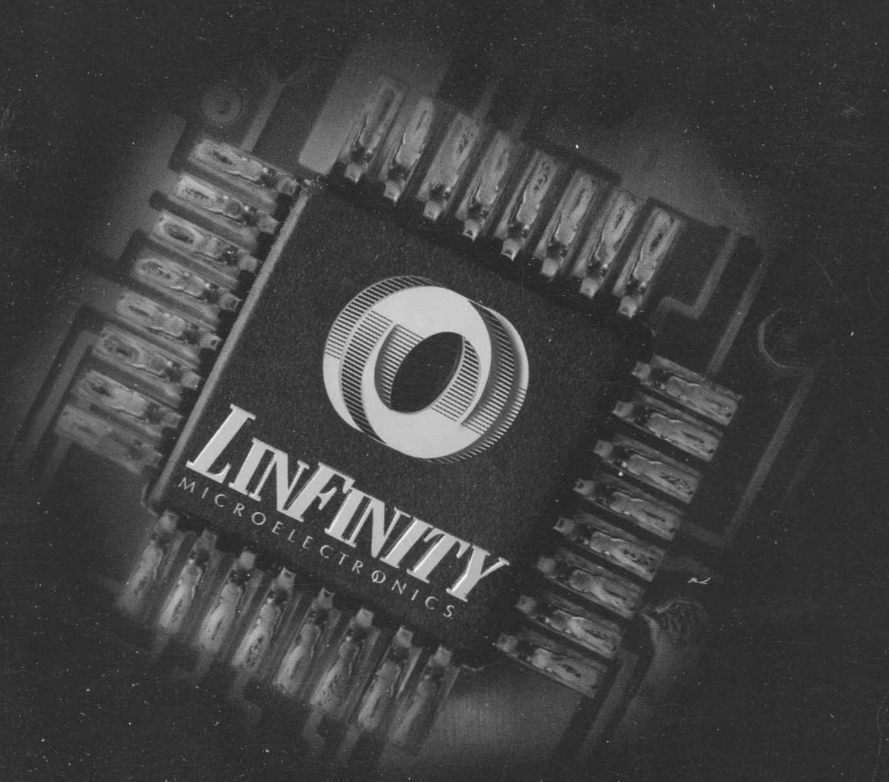
LINFINITY
MICROELECTRONICS



THE INFINITE POWER OF INNOVATION
1996/1997 DATABOOK

PRODUCT DATABOOK

1996/1997

11861 Western Avenue
Garden Grove, CA 92841
714-898-8121, 714-893-2570
Toll Free: 800-LMI-701

LINFINITY
MICROELECTRONICS

PRODUCT DISCLAIMER

The information furnished herein by Linfinity Microelectronics Inc. is believed to be accurate and reliable. However, the company cannot assume responsibility for use of any circuitry other than the circuitry entirely embodied in a Linfinity product; nor for any infringements of patents or other rights of third parties that may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Linfinity Microelectronics.

Linfinity advises that customers seek the latest version of relevant information to verify that the information being relied upon is current. Any warranty of Linfinity is contained in the purchase order for the Linfinity product and no other warranty, expressed or implied, is given by Linfinity. Testing and other quality control techniques are utilized to the extent Linfinity deems necessary to support this warranty. Linfinity reserves the right to change the circuitry and specifications in addition to discontinuing products without notice.

Life Support: Linfinity does not authorize or warrant any Linfinity product for use in life support devices and/or systems. Use of any Linfinity product in such life support systems without the express written authorization of the President of Linfinity Microelectronics is prohibited.

CLEAN AIR ACT OF 1990

Linfinity Microelectronics Inc. is in full compliance with the Clean Air Act of 1990 as defined by the Environmental Protection Agency (EPA) in the Stratosphere Ozone Protection's Final Rule Summary, dated March 1993. Because of this, an ODC Warning Label is not required for Linfinity's products.

Important Notice: Linfinity Microelectronics Inc. (LMI) reserves the right to make changes to or to discontinue any product or service identified with this publication without notice. LMI advises its customers to obtain the latest version of the relevant information to verify, before placing orders, that the information being relied upon is current.

Please be advised that LMI warrants its semiconductor products and related software to the specifications applicable at the time of sale in accordance with LMI's standard warranty. LMI assumes no liability for applications assistance, software performance, or third-party product information, or for infringement of patents or services described in this publication. LMI assumes no responsibility for customers' applications or product designs.

Index

Bold = New Product, **_*Bold Italic_** = Preliminary

LINFINITY
MICROELECTRONICS

Index

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LINFINITY MICROELECTRONICS

Table Of Contents

SECTION

LINFINITY MICROELECTRONICS

Table Of Contents

SECTION

LINFINITY MICROELECTRONICS

Thumb Index

LINFINITY
MICROELECTRONICS

Notes

LINFINITY
MICROELECTRONICS

Thumb Index

LINFINITY MICROELECTRONICS

Introduction

A Message From The President

July 1, 1996
From the Office of the President
Linfinity Microelectronics Inc.

Dear Valued Customer,

As president of Linfinity Microelectronics Inc., I am pleased to present Linfinity's 96/97 Product Databook. The last year has seen many exciting developments at Linfinity as we have introduced a vast array of new products, which are detailed in this Product Databook. Those products include linear and mixed-signal integrated circuits and modules for power supply, data communications and signal conditioning applications.

Working closely with our distributors, sales representatives and customers, we use a unique combination of system and IC expertise to envision, architect and develop new products, both at the IC and module level. As a result, many of the products we have introduced dramatically improve the performance, power efficiency, ease of use, size requirements, cost and, hence, overall value of our customers' product designs. We will continue this strong commitment to both understanding our customers' needs and providing them the support tools necessary for the successful evaluation and use of our products.

Linfinity has a comprehensive Quality and Reliability program integrating vendor participation, design engineering and manufacturing to produce reliable and high quality linear and mixed-signal circuits available. Linfinity is ISO9001 certified and has also joined a select group of semiconductor suppliers that have achieved full QML Certification. In addition, we are a self-qualification facility for many OEM accounts.

We, the employees of Linfinity Microelectronics Inc., are excited about our company and our new products. We are committed to providing linear and mixed-signal system solutions for your new products, resulting in additional advantages for you in your highly competitive markets. So look over our new 1997/1997 Product Databook and give us a call to help provide you solutions to meet your linear and mixed-signal needs.

Regards,

Brad Whitney
President and Chief Operating Officer
Linfinity Microelectronics Inc.

LinFinity

The Infinite Power Of Innovation

Corporate Headquarters
11861 Western Ave.
Garden Grove
California 92841

714-898-8121
FAX 714-893-2570

LinFinity Microelectronics

MISSION STATEMENT

LINFINITY MICROELECTRONICS' MISSION IS TO PROVIDE PRODUCTS AND SERVICES THAT HAVE AN **ADDED VALUE** TO OUR CUSTOMERS.

QUALITY POLICY

LINFINITY MICROELECTRONIC'S GOAL IS TO PROVIDE OUR CUSTOMERS WITH PRODUCTS AND SERVICES WHICH CONSISTENTLY ACHIEVE A LEVEL OF QUALITY THAT ***MEETS*** OR ***EXCEEDS*** OUR CUSTOMERS' REQUIREMENTS.

OUR GOAL IS CONTINUOUS IMPROVEMENT, EXCELLENCE IN ALL OUR ENDEAVORS AND TOTAL CUSTOMER SATISFACTION.

DEVELOPMENT PRINCIPLES

ALL PRODUCTS AND SERVICES WE PROVIDE MUST MEET THE FOLLOWING CRITERIA:

- ADD A PERCEIVED ***VALUE*** TO THE BUYING CONSUMER
- BE DIFFICULT FOR A COMPETITOR TO IMITATE
- BE LEVERAGABLE IN MANY DIVERSE MARKETS

TO ADD ***VALUE***, WE MUST SIGNIFICANTLY IMPACT AT LEAST TWO OF THE FOLLOWING CONSUMER CARE-ABOUTS:

- PERFORMANCE
- EASE OF USE
- POWER CONSUMPTION
- SIZE
- COST

Continuing the Transition...

SILICON GENERAL
1968-1993

LINFINITY
1994 to the *Future*

WHAT ABOUT THE NAME CHANGE?

By now you've noticed from the front cover that we've changed our name from Silicon General Semiconductors to Linfinity Microelectronics Inc. Why? How will it affect me? and What does the name mean? are the most commonly asked questions from our customers. The following paragraphs help to explain these questions.

Effective June 28th, 1993, Silicon General Semiconductor adopted the new name Linfinity Microelectronics Inc. There were several reasons for the name change. To begin with, we have become a wholly owned subsidiary of the parent Silicon General Corporation (effective 11-1-93 the parent Silicon General Corporation changed it's name to Symmetricom, Inc.). The Silicon General Corporation operated a semiconductor division (now a subsidiary, Linfinity Microelectronics Inc.) in Garden Grove, California, and a telecom systems division (Telecom Solutions) in San Jose, California. This action required a name change on our part. But more important than changing our name, we wanted to signify a new dedication to develop value-added products and services that are market driven. These products and services will offer high-growth potential for our company, our employees and, most importantly, our customers. We want to send the message of a bright future, a future with new and innovative products helping our customers reach new levels of functionality and performance in their future-generation products.

WHAT'S IN A NAME?

And where did the name Linfinity come from? Silicon General's history is deeply rooted in Linear integrated circuits as are our marketing, design, fabrication and product engineering experiences. Linfinity's future is focused on Linear and Linear driven Mixed Signal products. The cumulative experience of the old and new employees of Linfinity runs into the thousands of years. We are dedicated to putting this experience to work in driving Linear performance to new levels using our best and brightest ideas. Linfinity is the combination of the Linear focus and the infinite possibilities and opportunities the analog world offers ....

LINFINITY

WHAT ELSE HAS CHANGED?

Maybe it's best to start out by saying what isn't changing. There are no changes to the existing products and services we provide you, our valued customers. The people and factory remain the same as does our dedication to provide our best efforts in all our endeavors. However, we have changed our business direction and strategy. We are expanding the value-added products and services in markets we currently serve such as power supply systems, while adding product lines to service new, high-growth markets such as signal conditioning, data communications, and motion control systems. Linfinity is focusing its resources on market driven Linear and Mixed Signal products for the commercial, industrial and military markets that will drive the systems of this decade as well as those of the next century. This is an exciting time for Linfinity and our customers.

INTRODUCTION TO LINFINITY

A MESSAGE FOR OUR NEW CUSTOMERS

Over the years Silicon General Semiconductors has done business with a wide variety of customers in the Commercial, Industrial and Aerospace markets with a clear emphasis on Aerospace. Linfinity's new direction places emphasis on developing products for the Commercial and Industrial Markets, while still making products available for Aerospace use. So if you are a new customer from the Commercial or Industrial market you are probably not acquainted with our technological and manufacturing capabilities.

Process Capabilities

To that end, first and foremost we are a Linear house whose wafer fabrication technology is integral to providing leading-edge products. Linfinity's wafer fabrication is located in Garden Grove, California, roughly two blocks from our headquarters on Western Avenue in Garden Grove. Our technology is based on three mainline processes, a Linear Bipolar, CMOS and a Mixed Signal BiCMOS process from which we offer a variety of voltage, speed and density options. We are continuously upgrading and adding options to our fabrication technologies so we encourage you to contact us for more detailed specifications on these processes.

Assembly/Test Capabilities

In the area of packaging, Linfinity offers a wide range of surface mountable and thru-hole packages, all of which are described in greater detail later in this databook. Linfinity's Garden Grove facility handles a variety of plastic and ceramic packages with full production and prototyping capabilities combined with production testing. In fact, our facility has been certified to QML status of MIL-I-38535. See the quality section later in this databook for full details. Additionally, Linfinity's high-volume packaging and test capability resides in several pacific rim countries. Packaging options include surface-mountable plastic and ceramic in addition to their thru-hole compliments. As detailed in the Package Information section, Linfinity has the latest in packaging technology, including TQFP (thin quad flat pack) for high pin count mixed signal applications and the very thin TSSOP (thin small shrink outline package) for lower pin count analog applications. Capacity wise, Linfinity has volume capability in both wafer fabrication and assembly/test facilities sufficient to meet today's commercial demands. In addition to the process capabilities required by our military certification, we also offer the following process options for our space-level and Ultra-High Reliability applications:

- PIND Testing
- X-Ray
- Radiation Testing
- Wafer Lot Acceptance
- Customer Source Inspection Program
- Custom Data Capability

So if you are a new customer, welcome to the world of Linfinity Microelectronics. We look forward to doing business with you.

SUMMARY

We at Linfinity value our customers and are working tirelessly to provide better products and services to meet our industry's demanding requirements for performance, quality, reliability, availability and value. This is a new and exciting time for us as we look to meet the demands of the Linear and Mixed Signal markets of the future. Come grow with us by putting the "Infinite Power of Innovation" to work for you.

LINFINITY MICROELECTRONICS

Notes

Thumb Index

LINFINITY MICROELECTRONICS

QUALITY POLICY

LINFINITY MICROELECTRONIC'S GOAL IS TO PROVIDE OUR CUSTOMERS WITH PRODUCTS AND SERVICES WHICH CONSISTENTLY ACHIEVE A LEVEL OF QUALITY THAT *MEETS* OR *EXCEEDS* OUR CUSTOMERS' REQUIREMENTS.

OUR GOAL IS CONTINUOUS IMPROVEMENT, EXCELLENCE IN ALL OUR ENDEAVORS AND TOTAL CUSTOMER SATISFACTION.

QUALITY AND THE LINFINITY STANDARD

Linfinity Microelectronics Inc. has instituted a program of Continuous Quality Improvement in all aspects of its business. Quality is an integral part of the daily operation of all departments company wide. The Quality function assists in the facilitation of new concepts and ideas in the spirit of continuous improvement. And, to signify the importance at all levels of the organization, the Quality Assurance Manager reports directly to the President and has the responsibility and authority in all matters affecting Quality and Reliability. Activities such as ISO9001 certification and dedication to QML are key indicators of our commitment to Quality and Continuous Improvement.

KEMA ACCREDITED ANSI-RAB REGISTRAR

ISO 9001

CERTIFICATE #101 10.01

CONTINUOUS QUALITY IMPROVEMENT INITIATIVE

In the spirit of maintaining an aggressive program of quality and reliability improvement, Linfinity has identified three customer-critical areas for focus.

- **Performance to Specification**
- **Performance to Commitment**
- **Customer Satisfaction**

Each of these goals is described briefly below.

Performance to Specification

Meeting published or implied specifications is absolutely critical to meeting company and customer expectations. Whether it is a process limit or final product specification limit, they are equally important in maintaining a high level of quality and consistency. Utilizing tools, such as Statistical Process Control (SPC) and Statistical Quality Control (SQC), enables measurable objectives and goals.

Performance to Commitment

Across all organizations, at all levels, extending to our distributors and customers, performance to commitment often is the measure of difference between success and failure. The rate at which our industry moves forward is unprecedented in history and being able to count on your suppliers is more important than ever. Not only is meeting delivery schedules important, but meeting product development, sampling, literature and a host of other events are of equal importance. The employees of Linfinity are striving to beat the commitment at all levels by knowing our performance in the past, measuring it in the present and continually improving our goals for the future.

Customer Satisfaction

There is one, bottom-line measurement of performance in this area. Our customer's requirements (internal or external) have been met or exceeded. When queried, our customers respond with a confident "Yes, I'm happy, satisfied and I'll be back to do business again!"

KEY MEASUREMENT INDICES / PERFORMANCE CRITERIA

Product Qualification

It is the intention of Linfinity to assure that each newly-designed device is thoroughly qualified prior to its production release. A formal routine of qualifying procedures are followed for each new device type. Included in this procedure is a reliability validation of the first three candidate lots according to the schedule in Table 1.

Table 1

PRODUCT QUALIFICATION SCHEDULE

TEST	CONDITIONS	SS/ACC No.
Autoclave	15 PSIG, 121°C, 96 Hours	50 / 0
Temperature Cycle	-65°C to +150°C, 100 Cycles	50 / 0
Operating Life Test	+125°C, 1000 Hours or equivalent	50 / 0
Thermal Shock	-55°C to +125°C, 100 Cycles	50 / 0
HAST (Biased)	+130°C, 85% RH, 100 Hours	50 / 0

On-Going Product Reliability Monitors

The Reliability Monitoring Program at Linfinity is intended to determine the continuing acceptability of the product line. This program includes both short-term and extended-range testing on key package and device performance indices. Periodic and regular sampling of current production by generic package and device types assures a constant affirmation of device reliability. See Table 2.

Table 2

PRODUCT RELIABILITY MONITOR CONDITIONS

TEST		SS/ACC No.	MONITOR CONDITIONS	EXTENDED CONDITIONS
Autoclave	(15 PSIG)	50 / 0	96 Hours	168 Hours
Temperature Cycle	(-65°C to +150°C)	50 / 0	100 Cycles	1000 Cycles
Operating Life Test	(+125°C)	50 / 0	1000 Hours	2000 Hours
Thermal Shock	(-55°C to +125°C)	50 / 0	100 Cycles	1000 Cycles
HAST (Biased)	(+130°C)	50 / 0	100 Hours	300 Hours

KEY MEASUREMENT INDICES / PERFORMANCE CRITERIA

Outgoing Product Quality Levels

The Outgoing Quality level is monitored and computed by Quality Assurance on a scheduled basis. Each lot is sampled and inspected for conformance to specification. Only lots with zero defects in the sample are accepted. See Figure 1.

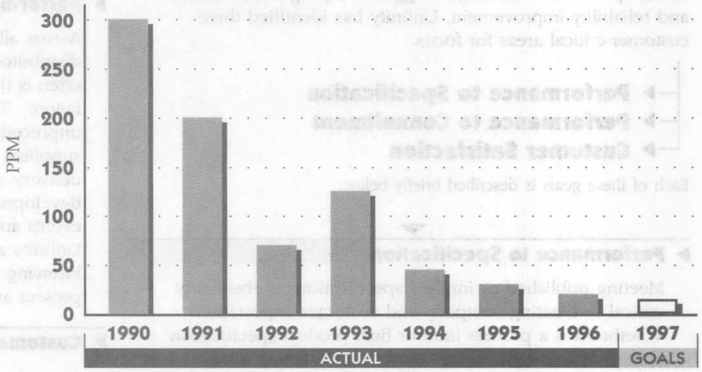


Figure 1

OUTGOING QUALITY HISTORY WITH PERFORMANCE GOALS
(CALCULATED NUMBER OF DEFECTS IN PPM)

Performance To Schedule

Critical to meeting our commitments, Performance-to-Schedule is an ideal index to measure our performance in our customer's eyes as well as to benchmark our competition. As can be seen by the numbers in Figure 2, we are performing at a very high level in a period of heavy market demand. And, as indicated by our goals for the future, we will continue to strive for 100% on-time delivery to our commitments.

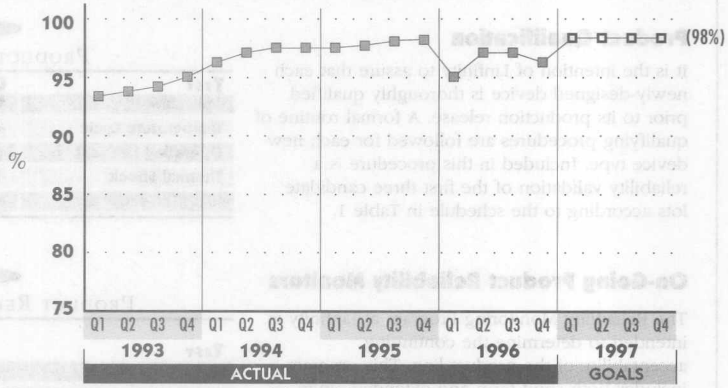


Figure 2

ON-TIME DELIVERY -- PERFORMANCE TO SCHEDULE

LINFINITY MICROELECTRONICS

INDUSTRY CERTIFICATION CREDENTIALS

Quality Assurance at Linfinity Microelectronics Inc. has been designed to be in conformance with several Military and Commercial grade quality and inspection system requirements. The Quality Assurance system has been certified by many OEM customers and Government Agencies to be in conformance with one or more of the following specifications:

CERTIFICATION REQUIREMENT	CERTIFYING AGENCY
ISO9001 (Quality System)	KEMA Registered Quality The Dutch Council For Certification (RvC) The Registrar Accreditation Board (RAB) The European Network For Quality System Assessment And Certification (EQNet)
Self Qualification Status	DELCO Elect., Kokomo, Indiana
MIL-Q-9858A (Quality System)	OEM Customers
MIL-I-45208A (Inspection System)	OEM Customers
MIL-PRF-38535 (General Specification for QML Microcircuits)	DESC-ELSC, Dayton, Ohio
Standard Military Drawing Certification	DESC-ELDS, Dayton, Ohio
MIL-S-19500 (General Specification for QPL Semiconductor Devices)	DESC-ELST, Dayton, Ohio

QUALITY AND RELIABILITY QUESTIONS

For any questions regarding Quality and Reliability, whether they may be about data, documentation, processing, or non-conforming products or services, use the following instructions.

1. Call 714-898-8121.
2. Indicate you have a question regarding *Quality and Reliability*.
3. If it is product specific, please have the *device number*.
4. If it is documentation or test related, indicate you have a *Documentation* question.
5. The receptionist will forward you to the correct Q&R contact.

Quality

HIGH-RELIABILITY SCREENING PROCEDURES FOR LINEAR IC'S

LINEAR INTEGRATED CIRCUITS

Linfinity manufactures hermetic products to the three standard levels of quality assurance processing outlined below. In addition, the company's unique flexibility allows ready accommodations to special customer requirements. The following Class S and Class B screening procedures are in compliance with methods as detailed in MIL-STD-883.

Screen	Class S Method	Reqm't.	Class B Method	Reqm't.	Standard Product Method	Reqm't.
Wafer Lot Acceptance	5007	Sample	N/A		N/A	
Non-Destructive Bond Pull	2023	100%	N/A		N/A	
Internal Visual (Pre-Cap)	2010, Condition A	100%	2010, Condition B	100%	Commercial Visual	100%
Stabilization Bake	1008, Condition C 24 Hours @ 150°C	100%	1008, Condition C 24 Hours @ 150°C	100%	1008, Condition C 24 Hours @ 150°C	Optional
Temperature Cycling	1010, Condition C 10 Cycles, -65°C to +150°C	100%	1010, Condition C 10 Cycles, -65°C to +150°C	100%	1010, Condition C 10 Cycles, -65°C to +150°C	Optional
Constant Acceleration	2001, Applicable Condition per Package Type	100%	2001, Applicable Condition per Package Type	100%	2001, Applicable Condition per Package Type	Optional
Particle Impact Noise Detection (PIND)	2020, Condition A		N/A		N/A	
Hermeticity (Seal) a) Fine Leak b) Gross Leak	1014, Condition B 5 x 10^{-8} atm-cc/sec 1014, Condition C1	100% 100%	1014, Condition B 5 x 10^{-8} atm-cc/sec 1014, Condition C1	100% 100%	1014, Condition B 5 x 10^{-8} atm-cc/sec 1014, Condition C1	Sample Sample
Pre-Burn-in Electrical Test	Per Applicable Device Spec. Unit Serialization as required		Per Applicable Device Spec.		Per Applicable Device Spec.	
Burn-in Test	1015, Dynamic 240 Hours @ 125°C Minimum (Note: An additional 72 Hrs HTRB burn-in and interim electrical test as required)	100%	1015, Static or Dynamic 160 Hours @ 125°C Minimum or equivalent	100%	N/A	
Final Electrical Test a) DC @ 25°C b) DC @ Max. and Min. Rated Temp. c) Dynamic @ 25°C d) Functional @ 25°C	Per Applicable Device Spec.	 100% 100% 100% 100%	Per Applicable Device Spec.	 100% 100% 100% 100%	Per Applicable Device Spec.	 100% Sample 100% 100%
Hermeticity (Seal) a) Fine Leak b) Gross Leak	 1014, Condition B 5 x 10^{-8} atm-cc/sec 1014, Condition C1	 100% 100%	 N/A N/A		 N/A N/A	
Radiography	Method 2012	100%	N/A		N/A	
External Visual	Method 2009	100%	Method 2009	100%	Method 2009	100%
Quality Conformance Testing Group A Groups B, C (Class B only), D	5005 DC, AC Parameters 5005 Paragraph	 +25°C +125°C -55°C 3.5	5005 DC, AC Parameters 5005 Paragraph	 +25°C +125°C -55°C 3.5	 DC, AC Parameters	 +25°C

LINFINITY MICROELECTRONICS

JAN, JANTX & JANTXV Screening Procedures For MIL-S-19500/474 Diode Arrays

MIL-S-19500/474 DIODE ARRAYS

Screen	Method - MIL-STD-750	Requirement	Comments
Internal Visual (Pre-Cap)	MIL-STD-883 Method 2010 Cond. B	JANTXV only	Specified in MIL-S-19500/474
Stabilization Bake	1032 24 Hours @ 200°C	100%	
Temperature Cycling	1051 20 Cycles, -65°C to +175°C	100%	
Constant Acceleration	2006 20,000 g, Y_1 orientation	100%	
Hermeticity (Seal) a) Fine Leak b) Gross Leak	1071	 100% 100%	
Pre-Burn-in Electrical Test	Per Applicable Device Specification	100%	
Burn-in Test	1038 72 Hours @ 150°C	100%	As specified in MIL-S-19500/474
Final Electrical Test a) DC @ 25°C b) DC @ Max. and Min. Rated Temp. c) Delta Measurements	Per Applicable Device Specification	 100% 100% 100%	
Quality Conformance Testing Group A	External Visual DC, AC Parameters	 +25°C +150°C -55°C	Subgroup 1 Subgroups 2, 4, 6, 7 Subgroup 3 Subgroup 3
Groups B & C	Sample Testing		

Notes

Thumb Index

LINFINITY
MICROELECTRONICS

Working With Linfinity

ACCESSING INFORMATION AT LINFINITY

Timely access to information is critical to success in today's rapidly-evolving electronics marketplace. And knowing how to get information is as critical as the information itself. Linfinity understands this, and we are focused on ensuring access to all information no matter how trivial it may seem. Our information guidelines are set by you, our customers.

Each and every employee at Linfinity understands your importance to us and we pledge to make every effort, reasonable or unreasonable, to get you the information you need. This section describes the many Linfinity services available to you.

FIELD-BASED SERVICES

LOCAL REPRESENTATIVES

Starting the process, we have a world-class set of local representatives who are keenly aware of Linfinity's pledge to you. They are our local presence and provide service to meet your daily needs. They can assist in quotations, delivery, samples, technical literature and can act as liasons in scheduling and implementing customer-critical events. In support of our local representatives, the Linfinity Inside Sales team provides factory-based, real-time information and coordination of customer-critical activities such as corporate contracts, Electronic Data Interchange (EDI), and expedite and lead times. This strong combination of local and factory-based resources provides you with the industry-leading service and support that is critical to success in today's challenging markets. A complete geographical listing of our representative network is provided in Section 14. Some areas of the country are supported directly by Linfinity. If you are located in one of these areas, the information in Section 14 will provide you with the appropriate phone number to call.

DISTRIBUTION

Linfinity also has extensive coverage through the distribution channel. Our distributors work closely with the factory and our representative network to ensure they provide adequate stocking of all Linfinity products which are critical to customers in the area. The distributor network can work closely with your company to ensure they provide adequate stocking levels for a diverse set of business conditions relieving you of the burdensome job of managing inventory. And of equal importance, our distributors carry or have near immediate access to small quantities of products in most temperature, grade and packaging options to support evaluation, prototyping or preproduction runs. Additionally, all distributors stock Linfinity literature, providing quick and easy access to this information. For a complete listing of our distribution network organized by geography see Section 14.

FACTORY-BASED SERVICES

BUSINESS HOURS

Linfinity business hours are from 8:00 am to 5:00 pm Pacific Coast Time. We will make every effort to field all requests during the business day. If you call after hours, please leave a voice message and we will return your call the next business day.

TECHNICAL DOCUMENTATION

One of the elements critical to a successful design experience with Linear components is a designer's ability to understand and comprehend all conditions (environmentally and electrically) that their circuit must operate under. Documentation provided by component vendors is critical in this process. Linfinity's goal is to provide the best in technical literature, both from an aesthetic and, most importantly, technical standpoint. We will make every effort to anticipate the most probable applications and the subsequent need for information both from a guaranteed and typical operating standpoint along with an explanation of how the product functions in actual applications. We'll even include handy hints to help communicate application details.

There are several ways to access Linfinity technical documentation. First, our local representatives and distributors stock all our documentation. Second, the Linfinity Information Network (LIN) provides 24-hour, on-line access to FAX data sheets. To read more about how to gain access to LIN and its usage, see Section 4 later in this book. Third, during business hours, you can call Linfinity directly using the following instructions.

714-898-8121 Tech. Documentation Line

When using the Documentation line:

1. Identify your call as a Technical Documentation request.
2. The receptionist will forward your call appropriately.

LINFINITY MICROELECTRONICS

FACTORY-BASED SERVICES (cont'd.)

APPLICATION INFORMATION

If you have a question regarding the use of our products in your application, we will be happy to assist you. Our staff of experienced applications engineers are very familiar with the product line as well as many of the common and not so common applications for them. But oftentimes, it is very difficult to visualize a customer's specific application via a phone conversation and as such we recommend faxing even the simplest application schematics prior to your call. This will ensure that we interpret your questions accurately and provide the most expedient, technically correct answer possible. However, we also understand that some questions can be answered with a simple phone call. We will make every attempt to be available to answer your calls or to call you back within the hour. Use the following information when you need applications assistance.

FAX 714-372-3566 Application Info. Line

When using the Application FAX line:

1. Clearly label your FAX with the words: Application Question.
2. Clearly label your FAX with the words: Part Number (e.g., LX1562).
3. Include a schematic with highlighted problem area along with a written description. Label all significant nodes with corresponding electrical conditions.
4. Be sure to provide your name, voice phone number and company name.

VOICE 714-898-8121 Application Info. Line

When using the Application Voice line:

1. Identify your call as an Application Question.
2. Provide the product part number (e.g., LX1562).
3. Indicate if you have pre-sent a FAX.
4. The receptionist will forward your call to the appropriate Applications Engineer.

FACTORY-BASED SERVICES (cont'd.)

TECHNICAL PRODUCT INFORMATION

In addition to the specific application of products, there are product-specific questions. Examples include, certain parametric and functional performance attributes, test conditions, extraneous operating conditions, unspecified parameters or simple product quirks. These types of questions are best answered by the engineer (product, test, or design) who works with the product on a daily basis.

We are happy to make these people available to get you the answer as quickly as possible. Just like the applications assistance above, we suggest you use the following procedure to speed you through the Linfinity system. We suggest faxing your questions ahead of your call to ensure we have a clear understanding of your specific request.

FAX 714-372-3566 Product Info. Line

When using the Product FAX line:

1. Clearly label your FAX with the words: Product Question.
2. Clearly label your FAX with the words: Part Number (e.g., LX1562).
3. Include a written description, highlighting the problem area. Label all significant nodes with corresponding electrical conditions.
4. Be sure to provide your name, voice phone number and company name.

VOICE 714-898-8121 Product Info. Line

When using the Application Voice line:

1. Identify your call as a Product Question.
2. Provide the product Part Number (e.g., LX1562).
3. Indicate if you have pre-sent a FAX.
4. The receptionist will forward your call to the appropriate Engineer.

Working With Linfinity

FACTORY-BASED SERVICES (cont'd.)

FUTURE PRODUCT PLANS OR OFFERINGS

Linfinity has on-going product development activities in the Power Supply, Signal Conditioning and Data Communication product areas. Because we are a market-driven company, we are continuously searching for new ideas and better ways to service these markets. We encourage you to call us with product requirements you have identified as critical to your success. We will discuss our plans with you to see if our plans match your needs. We pledge to evaluate and respond to your requirements. Who knows, your product may be just around the corner!

If you have a question about our Future Products:

1. Call **714-898-8121**.
2. Tell the receptionist that you have a question about Future Products.
3. The receptionist will forward you to the appropriate Marketing Engineer.

QUALITY AND RELIABILITY INFORMATION

Linfinity has instituted a program of Continuous Quality Improvement in all aspects of our business. Quality is an integral part of the daily operation of all departments company wide and not just the sole responsibility of the Quality department. The Quality function assists in facilitating new concepts and ideas within the company, while also acting as a clearing house and focal point for customer-critical inquiries. Section 2 is devoted solely to the explanation of Quality and Reliability at Linfinity. If you have questions relating to Quality and Reliability, simply refer to Section 2 for specific directions.

FACTORY BASED SERVICES (cont'd.)

COMPLAINTS, COMPLIMENTS OR OUTSTANDING ISSUES

Understandably, there will be issues which require our attention. We want to resolve those issues quickly to your absolute satisfaction. If the regular channels don't work, please use your judgement in contacting the appropriate functional area and responsible Vice President.

Functional Areas

— ▶ **Development**
— ▶ **Manufacturing**
— ▶ **Marketing**
— ▶ **Sales**

For all complaints, compliments and outstanding issues:

1. Call **714-898-8121**.
2. Tell the receptionist that you have a Development, Manufacturing, Marketing, or Sales Issue that you need to speak to someone about.
3. Be prepared with your company name and location.
4. The receptionist will forward your call appropriately.

ALL OTHER QUESTIONS

If after reviewing this information, you still aren't sure who to ask for or what to do, simply follow these instructions.

For all other questions:

1. Call **714-898-8121**.
2. Tell the receptionist that you have a General Question.
3. Be prepared with your company name and location.
4. The receptionist will forward your call appropriately.

LINFINITY MICROELECTRONICS

Thumb Index

LINFINITY MICROELECTRONICS

Linfinity Information Network

INTRO TO THE LINFINITY INFORMATION NETWORK

INTRODUCTION

To provide our customers with the highest level of service possible, Linfinity has implemented the Linfinity Information Network (LIN). The LIN network provides 24-hour a day, 7-day a week, worldwide access to product documentation, instantly eliminating the age old problems of conflicting time zones and work schedules. Not only do our customers have instant access to existing product documentation, they are first in line for available documentation on newly released products. In addition, all documents are electronically generated and stored on the LIN network, providing the highest quality image available for FAX systems. No more blurred or illegible documents.

It is our intention to provide fast, accurate, easy access to critical documentation giving our customers that competitive edge in the ever quickening race to market. Read on to find out how to enroll in LIN and how to use it to your competitive advantage.

HOW TO ENROLL

There are two ways to gain access to **LIN**:

1. Simply fill out the attached business reply card and drop it off at your nearest post office

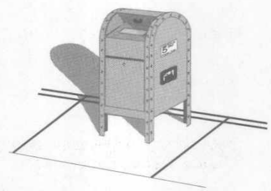
•• OR ••

2. Call 714-898-8121 and ask to be enrolled in the Linfinity Information Network.

The receptionist will forward you to the responsible data-entry person. Be prepared to provide demographic information such as name, address, city, state, company name, and voice/fax phone numbers.

Whether you use the reply card or the phone-in method, you will be assigned an ACCESS code allowing use of the system. Within two working days of receipt of your application, we will send you a personalized ACCESS CARD that can be carried in your wallet or stored in your business card file. If at any time you lose the card or simply don't have it readily available, simply call the number above and we can provide your ACCESS number once you have provided the proper identification.

Fill out the reply card.

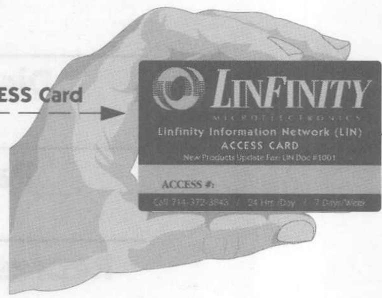


Drop it in a mailbox.

Call in.

Within a few working days.

Example ACCESS Card



LINFINITY MICROELECTRONICS

INTRO TO THE LINFINITY INFORMATION NETWORK

HOW TO USE THE LINFINITY INFORMATION

Simply call **(714) 372-3848**, any time of the day, any day of the week, from your FAX machine. The only prerequisites are an ACCESS number and a Document #.

DON'T FORGET THAT YOU
MUST CALL FROM A FAX MACHINE
IN ORDER TO RECEIVE THE REQUESTED DOCUMENT.

Enter your ACCESS number found on the front of your access card. Document numbers can be found in this catalog in two locations. First, in the Selection Guides (sections 6 through 10), each device type has a table labeled *LIN Document #'s*. In the table there are **Full** and **Summary** numbers. **Full** is a FAX document that represents a comprehensive, all inclusive data sheet that can have a significant number of pages. **Summary** is a FAX document that represents a condensed and consolidated version of the full data sheet that will typically have less than three pages. See the example below.

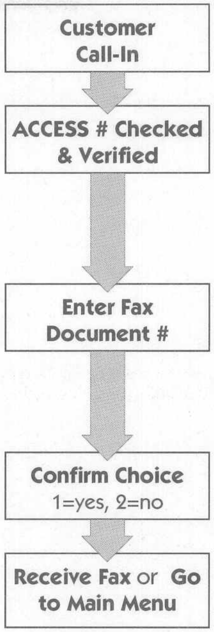
Example Fax Document # Table
-located in Selection Guides & Index

LIN Document #'s	
Summary	**Full**
15402	1540

A second location where document numbers can be found is in the Procuct Index on page 5-6.

The Product Index provides a comprehensive list of documents by device type. Once you are ready with your ACCESS and Document numbers, call the system and it will begin prompting you for information. For additional information, a flow chart and specific instructions are listed on the right side of this page.

SPECIFIC OPERATING INSTRUCTIONS



1 Call **714-372-3848.**

2 The Network will immediately request your ACCESS Number. Enter the number found on your ACCESS Card and it will be checked and verified by the network. In the event that the network rejects your ACCESS number, try entering the number again. If your number is still unrecognized, please call 714-898-8121 and ask for the LIN coordinator so we can fix the problem.

3 You will then be prompted for the document number of the fax you wish to receive. Enter any valid *LIN Document #,* found in all product selection guides (example this page) and in the Product Index (page 5-6). Your entry will be checked and the network will give a brief description and page count of the selected fax document.

4 Confirm your selection by pressing '1' for **yes**, or cancel your request by pressing '2' for **no**.

5 Finally, you will be given the option of receiving your fax document by pressing the pound '#' key, or returning to the main menu by pressing '1'. By returning to the main menu, you can select additional fax documents, for a total of three documents per call.

For a Current Product Index, Request Document # 1000
For a Current New Products Update List, Request Document # 1001

THE FUTURE OF THE LINFINITY INFORMATION NETWORK

Our goal is to be able to provide our customers with fast and easy access to information at Linfinity. The LIN network's first task is product data sheets but the future holds other capabilities as well. Access to other technical literature and documentation in addition to fulfillment activities for promotional programs are in the works. The pace of our industry is quickening at every corner and we fully intend to set the pace for the future. If you have any suggestions, questions or problems regarding the Network, please contact us at this number **714-898-8121** and ask for the LIN coordinator.

LINFINITY MICROELECTRONICS

Notes

Thumb Index

5

LINFINITY
MICROELECTRONICS

Product Selection

PRODUCT SELECTION BY FUNCTION

POWER SUPPLY CIRCUITS

PWM IC Controllers

LX1552	**Ultra-Low Start-Up Current, Current Mode PWM**	6-15
LX1553	**Ultra-Low Start-Up Current, Current Mode PWM**	6-15
LX1554	**Ultra-Low Start-Up Current, Current Mode PWM**	6-15
LX1555	**Ultra-Low Start-Up Current, Current Mode PWM**	6-15
LX1562	**Second-Generation Power Factor Controller**	6-33
LX1563	**Second-Generation Power Factor Controller**	6-33
****LX1570***	***Phase Mod. AC Synch. Sec.-Side Controller***	6-59
****LX1571***	***Phase Mod. AC Synch. Sec.-Side Controller***	6-59
LX1823	**High-Speed Current Mode PWM**	6-71
SG1524	Voltage Mode Pulse Width Modulator	6-239
SG1524B	Voltage Mode Pulse Width Modulator	6-241
SG1525A	Voltage Mode Pulse Width Modulator	6-243
SG1526	Voltage Mode Pulse Width Modulator	6-245
SG1526B	Voltage Mode Pulse Width Modulator	6-247
SG1527A	Voltage Mode Pulse Width Modulator	6-243
SG1529	Voltage Mode Pulse Width Modulator	6-249
SG1825C	High-Speed Current Mode PWM	6-267
SG1842	Current Mode Pulse Width Modulator	6-275
SG1843	Current Mode Pulse Width Modulator	6-275
SG1844	Current Mode Pulse Width Modulator	6-289
SG1845	Current Mode Pulse Width Modulator	6-289
SG1846	Current Mode Pulse Width Modulator	6-301
SG2524	Voltage Mode Pulse Width Modulator	6-239
SG2524B	Voltage Mode Pulse Width Modulator	6-241
SG2525A	Voltage Mode Pulse Width Modulator	6-243
SG2526	Voltage Mode Pulse Width Modulator	6-245
SG2526B	Voltage Mode Pulse Width Modulator	6-247
SG2527A	Voltage Mode Pulse Width Modulator	6-243
SG2529	Voltage Mode Pulse Width Modulator	6-249
SG2825C	High-Speed Current Mode PWM	6-267
SG2842	Current Mode Pulse Width Modulator	6-275
SG2843	Current Mode Pulse Width Modulator	6-275
SG2844	Current Mode Pulse Width Modulator	6-289
SG2845	Current Mode Pulse Width Modulator	6-289
SG2846	Current Mode Pulse Width Modulator	6-301
SG3524	Voltage Mode Pulse Width Modulator	6-269
SG3524B	Voltage Mode Pulse Width Modulator	6-241
SG3525A	Voltage Mode Pulse Width Modulator	6-243
SG3526	Voltage Mode Pulse Width Modulator	6-245
SG3526B	Voltage Mode Pulse Width Modulator	6-247
SG3527A	Voltage Mode Pulse Width Modulator	6-243
SG3529	Voltage Mode Pulse Width Modulator	6-249
SG3561A	Power Factor Controller	6-325
SG3825C	High-Speed Current Mode PWM	6-267
SG3842	Current Mode Pulse Width Modulator	6-275
SG3843	Current Mode Pulse Width Modulator	6-275
SG3844	Current Mode Pulse Width Modulator	6-289
SG3845	Current Mode Pulse Width Modulator	6-289
SG3846	Current Mode Pulse Width Modulator	6-301
UC1842A	**Current Mode PWM Controller**	6-357
UC1843A	**Current Mode PWM Controller**	6-357
UC1844A	**Current Mode PWM Controller**	6-357
UC1845A	**Current Mode PWM Controller**	6-357
UC2842A	**Current Mode PWM Controller**	6-357
UC2843A	**Current Mode PWM Controller**	6-357
UC2844A	**Current Mode PWM Controller**	6-357
UC2845A	**Current Mode PWM Controller**	6-357
UC3842A	**Current Mode PWM Controller**	6-357

POWER SUPPLY CIRCUITS (cont'd.)

PWM IC Controllers (continued)

UC3843A	**Current Mode PWM Controller**	6-357
UC3844A	**Current Mode PWM Controller**	6-357
UC3845A	**Current Mode PWM Controller**	6-357

Low Dropout Positive Voltage Regulators

****LX8020***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020-28***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A-28***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020-30***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A-30***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020-33***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A-33***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020-48***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A-48***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020-50***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8020A-50***	***Ultra-Low Dropout Regulator (ULDO™)***	6-99
****LX8383***	***7.5A LDO Positive Adj. Regulator***	6-103
****LX8383A***	***7.5A LDO Positive Adj. Regulator***	6-103
LX8384	**5A LDO Positive Adj. Regulator**	6-111
LX8384A	**5A LDO Positive Adj. Regulator**	6-111
LX8385	**3A LDO Positive Adj. Regulator**	6-119
LX8386	**1.5A LDO Positive Adj. Regulator**	6-127
****LX8554***	***5A Extremely LDO Positive Adj. Regulator***	6-135
****LX8582A***	***8.5A LDO Positive Adj. Regulator***	6-137
****LX8584***	***7A LDO Positive Adj. Regulator***	6-139
****LX8584A***	***7A LDO Positive Adj. Regulator***	6-139
****LX8584B***	***7A LDO Positive Adj. Regulator***	6-139
LX8585	**4.6A LDO Positive Adj. Regulator**	6-141
LX8585A	**4.6A LDO Positive Adj. Regulator**	6-141
****LX8586***	***6A LDO Positive Adj. Regulator***	6-143
****LX8586A***	***6A LDO Positive Adj. Regulator***	6-143
****LX8587***	***3A LDO Positive Adj. Regulator***	6-149
****LX8587A***	***3A LDO Positive Adj. Regulator***	6-149
LX8940	**5V LDO Regulator**	6-151
****LX8941***	***Adjustable Low Dropout Regulator***	6-155

Standard Linear Voltage Regulators

****LX5285***	***800mA LDO Source & Sink 2.85V Regulator***	6-81
SG109	Positive Fixed Voltage Regulator	6-227
SG117	Positive Adjustable Voltage Regulator	6-229
SG117A	Positive Adjustable Voltage Regulator	6-229
SGR117A	Rad Hard 1.5A Adjustable Voltage Regulator	6-231
SG120-5	Negative Fixed Voltage Regulator	6-233
SG120-5.2	Negative Fixed Voltage Regulator	6-233
SG120-8	Negative Fixed Voltage Regulator	6-233
SG120-12	Negative Fixed Voltage Regulator	6-233
SG120-15	Negative Fixed Voltage Regulator	6-233
SG120-18	Negative Fixed Voltage Regulator	6-233
SG120-20	Negative Fixed Voltage Regulator	6-233
SG137	1.5A Negative Adjustable Voltage Regulator	6-235
SG137A	1.5A Negative Adjustable Voltage Regulator	6-235
SG140-5	Positive Fixed Voltage Regulator	6-237
SG140A-5	Positive Fixed Voltage Regulator	6-237
SG140-6	Positive Fixed Voltage Regulator	6-237
SG140-8	Positive Fixed Voltage Regulator	6-237
SG140-12	Positive Fixed Voltage Regulator	6-237

Bold = New Product, ****Bold Italic*** = Preliminary

LINFINITY MICROELECTRONICS

POWER SUPPLY CIRCUITS (cont'd.)

Standard Linear Voltage Regulators *(continued)*

POWER SUPPLY CIRCUITS (cont'd.)

Supervisors

MOSFET Drivers

Support Functions

Switching Regulator Output Stages

Modular Products

Bold = New Product, ***Bold Italic*** = Preliminary

Product Selection

PRODUCT SELECTION BY FUNCTION

POWER SUPPLY CIRCUITS (cont'd.)

Modular Products (continued)

***LXM1598-01**	***12V CCFL Inverter Module***	6-197
***LXM1600-05**	***5V Pentium® Pro VRM***	6-203
***LXM1600A-05**	***5V Pentium Pro VRM***	6-203
***LXM1600-12**	***12V Pentium Pro VRM***	6-203
***LXM1600A-12**	***12V Pentium Pro VRM***	6-203

DATA COMMUNICATIONS CIRCUITS

SCSI Terminators

LX5107	**9-Line Low Cap., µPower SCSI Terminator**	7-5
LX5202	**18-Line µPower SCSI Terminator**	7-11
LX5203	**9-Line SCSI Active Terminator**	7-15
LX5204	**9-Line Hot Swap, µPower SCSI Terminator**	7-19
LX5207	**18-Line Low Cap., µPower SCSI Terminator**	7-23
LX5208	**18-Line Low Cap., µPower SCSI Terminator**	7-27
LX5212	**9-Line Low Cap., µPower SCSI Terminator**	7-31
LX5213	**9-Line Low Cap., µPower SCSI Terminator**	7-35
LX5218	**Low Voltage, 9-Channel SCSI Terminator**	7-39
LX5219	**Low Voltage, 9-Channel SCSI Terminator**	7-39
***LX5285**	***800mA LDO Source & Sink 2.85V Regulator***	6-81

SCSI Transceivers

***LX5268**	***40MHz Single-Ended 6-Chan. Bus Transceiver***	7-51
***LX5269**	***40MHz Single-Ended 6-Chan. Bus Transceiver***	7-59

SIGNAL CONDITIONING CIRCUITS

Operational Amplifiers

SG143	High-Voltage Operational Amplifier	8-45
SG1436	High-Voltage Operational Amplifier	8-49
SG1536	High-Voltage Operational Amplifier	8-49

Voltage Reference

LM385	**1.2V & 2.5V Micropower Voltage Reference**	8-7
LM385B	**1.2V & 2.5V Micropower Voltage Reference**	8-7
LX1004	**1.2V & 2.5V Micropower Voltage Reference**	8-15
LX1431	**Programmable Reference**	8-23
LX6431	**Precision Programmable Reference**	8-31
LX6431A	**Precision Programmable Reference**	8-31
LX6431B	**Precision Programmable Reference**	8-31
SG103-1.8	Voltage Reference Circuit	8-43
SG103-2.4	Voltage Reference Circuit	8-43
SG103-2.7	Voltage Reference Circuit	8-43
SG103-3.3	Voltage Reference Circuit	8-43
SG103-4.7	Voltage Reference Circuit	8-43
SG103-5.1	Voltage Reference Circuit	8-43
SG1503	Precision 2.5V Reference	8-47
SG2503	Precision 2.5V Reference	8-47
SG3503	Precision 2.5V Reference	8-47
TL431	**Precision Programmable Reference**	8-51
TL431A	**Precision Programmable Reference**	8-51
TL431B	**Precision Programmable Reference**	8-51

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MOTION CONTROL CIRCUITS

Disk Drive Products

***LX3187**	***Servo Actuated Drive Subsystem***	9-7
***LX3191B**	***Hall-less Spindle Motor Driver***	9-19

Power Drivers

SG1635	2A Half-Bridge Driver	9-33
SG3635	2A Half-Bridge Driver	9-33
SG3645	Quad 2.5A Power Driver	9-47

PWM Controllers

SG1731	DC Motor Pulse Width Modulator	9-35
SG2731	DC Motor Pulse Width Modulator	9-35
SG3731	DC Motor Pulse Width Modulator	9-35

Power Operational Amplifiers

SG2273	Power Operational Amplifier	9-37
SG3272	Dual-Power Amplifier	9-45
SG3273	Power Operational Amplifier	9-37

OTHER LINEAR CIRCUITS

Interface Circuits

SG2001	High-Voltage, Medium Current Driver Array	10-9
SG2002	High-Voltage, Medium Current Driver Array	10-9
SG2003	High-Voltage, Medium Current Driver Array	10-9
SG2004	High-Voltage, Medium Current Driver Array	10-9
SG2011	High-Voltage, Medium Current Driver Array	10-9
SG2012	High-Voltage, Medium Current Driver Array	10-9
SG2013	High-Voltage, Medium Current Driver Array	10-9
SG2014	High-Voltage, Medium Current Driver Array	10-9
SG2015	High-Voltage, Medium Current Driver Array	10-9
SG2021	High-Voltage, Medium Current Driver Array	10-9
SG2023	High-Voltage, Medium Current Driver Array	10-9
SG2024	High-Voltage, Medium Current Driver Array	10-9
SG2801	High-Voltage, Medium Current Driver Array	10-11
SG2802	High-Voltage, Medium Current Driver Array	10-11
SG2803	High-Voltage, Medium Current Driver Array	10-11
SG2804	High-Voltage, Medium Current Driver Array	10-11
SG2811	High-Voltage, Medium Current Driver Array	10-11
SG2812	High-Voltage, Medium Current Driver Array	10-11
SG2813	High-Voltage, Medium Current Driver Array	10-11
SG2814	High-Voltage, Medium Current Driver Array	10-11
SG2815	High-Voltage, Medium Current Driver Array	10-11
SG2821	High-Voltage, Medium Current Driver Array	10-11
SG2823	High-Voltage, Medium Current Driver Array	10-11
SG2824	High-Voltage, Medium Current Driver Array	10-11
SG55325	Dual Source / Dual Sink Memory Driver	10-19
SG55326	Quad Sink Memory Driver	10-21
SG55327	Quad Source Memory Driver	10-23
SG55450B	Dual Peripheral Positive - AND Driver	10-25
SG55451B	Dual Peripheral Positive - AND Driver	10-27
SG55452B	Dual Peripheral Positive - NAND Driver	10-29
SG55453B	Dual Peripheral Positive - OR Driver	10-31
SG55454B	Dual Peripheral Positive - NOR Driver	10-33
SG55460	Dual Peripheral Positive - AND Driver	10-25
SG55461	Dual Peripheral Positive - AND Driver	10-27

Bold = New Product, ***Bold Italic*** = Preliminary

LINFINITY MICROELECTRONICS

OTHER LINEAR CIRCUITS (cont'd.)

Interface Circuits (continued)

Transistor Arrays

Sense Amplifiers

Diode Arrays

Bold = New Product, ***Bold Italic*** = Preliminary

Product Index

PRODUCT SELECTION BY PART NUMBER

INDEX & LIN DOCUMENT NUMBERS

The following index serves two purposes. As a part number index, it lists all products numerically and the page number where they can be found. Also listed are the corresponding document numbers for all available fax documents on the Linfinity Information Network, or **LIN**. The Linfinity Information Network is a dedicated fax response system that provides the latest product documentation available, any time of day, any day of the week. Document numbers are given for both **Full** and **Summary** fax documents.

For complete information on the Linfinity Information Network, Document numbers, and how to gain access, see Page 4-2.

Bold = New Product, ***Bold Italic*** = Preliminary

*For Current Product Index Fax, Request Document # **1000***
*For New Product Update Fax, Request Document # **1001***

LINFINITY MICROELECTRONICS

Product Index

PRODUCT SELECTION BY PART NUMBER

INDEX & LIN DOCUMENT NUMBERS (cont'd.)

Part No.	LIN Document #'s Summary	Full	Page #
SG120-5.2	1202	120	6-233
SG120-08	1202	120	6-233
SG120-12	1202	120	6-233
SG120-15	1202	120	6-233
SG120-18	1202	120	6-233
SG120-20	1202	120	6-233
SG137	1372	137	6-235
SG137A	1372	137	6-235
SG140-05	1402	140	6-237
SG140A-05	1402	140	6-237
SG140-06	1402	140	6-237
SG140-08	1402	140	6-237
SG140-12	1402	140	6-237
SG140A-12	1402	140	6-237
SG140-15	1402	140	6-237
SG140A-15	1402	140	6-237
SG140-18	1402	140	6-237
SG140-24	1402	140	6-237
SG143	1432	143	8-45
SG1436	15362	1536	8-49
SG1503	15032	1503	8-47
SG1524	15242	1524	6-239
SG1524B	15246	15245	6-241
SG1525A	15252	1525	6-243
SG1526	15262	1526	6-245
SG1526B	15266	15265	6-247
SG1527A	15272	1527	6-243
SG1529	15292	1529	6-249
SG1532	15322	1532	6-249
SG1536	15362	1536	8-49
SG1540	15402	1540	6-253
SG1543	15432	1543	6-255
SG1544	15442	1544	6-257
SG1548	15482	1548	6-259
SG1549	15492	1549	6-261
SG1626	16262	1626	6-263
SG1635	16352	1635	9-33
SG1644	16442	1644	6-265
SG1731	17312	1731	9-35
SG1825C	18252	1825	6-267
SG1842	18422	1842	6-275
SG1843	18422	1842	6-275
SG1844	18442	1844	6-289
SG1845	18442	1844	6-289
SG1846	18462	1846	6-301
SG2001	20002	2000	10-9
SG2002	20002	2000	10-9
SG2003	20002	2000	10-9
SG2004	20002	2000	10-9
SG2011	20002	2000	10-9
SG2012	20002	2000	10-9
SG2013	20002	2000	10-9
SG2014	20002	2000	10-9

Part No.	LIN Document #'s Summary	Full	Page #
SG2015	20002	2000	10-9
SG2021	20002	2000	10-9
SG2023	20002	2000	10-9
SG2024	20002	2000	10-9
SG217	1172	117	6-229
SG217A	1172	117	6-229
SG2273	22732	2273	9-37
SG237	1372	137	6-235
SG237A	1372	137	6-235
SG2503	15032	1503	8-47
SG2524	15242	1524	6-239
SG2524B	15246	15245	6-241
SG2525A	15252	1525	6-243
SG2526	15262	1526	6-245
SG2526B	15266	15265	6-247
SG2527A	15272	1527	6-243
SG2529	15292	1529	6-249
SG2532	15322	1532	6-251
SG2540	15402	1540	6-253
SG2543	15432	1543	6-255
SG2544	15442	1544	6-257
SG2548	15482	1548	6-259
SG2549	15492	1549	6-261
SG2626	16262	1626	6-263
SG2644	16442	1644	6-265
SG2731	17312	1731	9-35
SG2801	28002	2800	10-11
SG2802	28002	2800	10-11
SG2803	28002	2800	10-11
SG2804	28002	2800	10-11
SG2811	28002	2800	10-11
SG2812	28002	2800	10-11
SG2813	28002	2800	10-11
SG2814	28002	2800	10-11
SG2815	28002	2800	10-11
SG2821	28002	2800	10-11
SG2823	28002	2800	10-11
SG2824	28002	2800	10-11
SG2825C	18252	1825	6-267
SG2842	18422	1842	6-275
SG2843	18422	1842	6-275
SG2844	18442	1844	6-289
SG2845	18442	1844	6-289
SG2846	18462	1846	6-301
SG29055	290552	29055	6-303
SG29055A	290552	29055	6-303
SG29085	290852	29085	6-305
SG29085A	290852	29085	6-305
SG29125	291252	29125	6-307
SG29125A	291252	29125	6-307
SG3081	30812	3081	10-13
SG309	1092	109	6-227
SG317	1172	117	6-229

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*For Current Product Index Fax, Request Document # **1000***
*For New Product Update Fax, Request Document # **1001***

LINFINITY
MICROELECTRONICS

Product Index

PRODUCT SELECTION BY PART NUMBER

INDEX & LIN DOCUMENT NUMBERS (cont'd.)

Part No.	LIN Document #'s Summary	Full	Page #
SG317A	1172	117	6-229
SG3272	32722	3272	9-45
SG3273	22732	2273	9-37
SG33164	331642	33164	6-309
SG337	1372	137	6-235
SG337A	1372	137	6-235
SG34164	331642	33164	6-309
SG3503	15032	1503	8-47
SG3524	15242	1524	6-239
SG3524B	15246	15245	6-241
SG3525A	15252	1525	6-243
SG3526	15262	1526	6-245
SG3526B	15266	15265	6-247
SG3527A	15272	1527	6-243
SG3529	15292	1529	6-249
SG3532	15322	1532	6-251
SG3540	15402	1540	6-253
SG3543	15432	1543	6-255
SG3544	15442	1544	6-257
SG3546	35462	3546	6-317
SG3548	15482	1548	6-259
SG3549	15492	1549	6-251
SG3561A	35612	3561	6-325
SG3626	16262	1626	6-263
SG3635	16352	1635	9-33
SG3644	16442	1644	6-265
SG3645	36452	3645	9-47
SG3731	17312	1731	9-35
SG3825C	18252	1825	6-267
SG3842	18422	1842	6-275
SG3843	18422	1842	6-275
SG3844	18442	1844	6-289
SG3845	18442	1844	6-289
SG3846	18462	1846	6-301
SG55236	552362	55236	10-17
SG55325	553252	55325	10-19
SG55326	553262	55326	10-21
SG55327	553272	55327	10-23
SG55450B	554502	55450	10-25
SG55451B	554512	55451	10-27
SG55452B	554522	55452	10-29
SG55453B	554532	55453	10-31
SG55454B	554542	55454	10-33
SG55460	554502	55450	10-25
SG55461	554512	55451	10-27
SG55462	554522	55452	10-29
SG55463	554532	55453	10-31
SG55464	554542	55454	10-33
SG55470	554502	55450	10-25
SG55471	554512	55451	10-27
SG55472	554522	55452	10-29
SG55473	554532	55453	10-31
SG55474	554542	55454	10-33

Part No.	LIN Document #'s Summary	Full	Page #
SG5768	57682	5768	10-35
SG5770	57682	5768	10-35
SG5772	57682	5768	10-35
SG5774	57682	5768	10-35
SM600	6002	600	6-351
SM601	6002	600	6-351
SM602	6002	600	6-351
SM610	6002	600	6-351
SG6100	61002	6100	10-37
SG6101	61002	6100	10-37
SM611	6002	600	6-351
SM612	6002	600	6-351
SM625	6252	625	6-353
SM626	6252	625	6-353
SM627	6252	625	6-353
SM645	6452	645	6-355
SM646	6452	645	6-355
SM647	6452	645	6-355
SG6506	57682	5768	10-35
SG6507	57682	5768	10-35
SG6508	57682	5768	10-35
SG6509	57682	5768	10-35
SG6510	61002	6100	10-37
SG6511	61002	6100	10-37
SG723	7232	723	6-345
SG75325	553252	55325	10-19
SG75326	553262	55326	10-21
SG75327	553272	55327	10-23
SG75450B	554502	55450	10-25
SG75451B	554512	55451	10-27
SG75452B	554522	55452	10-29
SG75453B	554532	55453	10-31
SG75454B	554542	55454	10-33
SG75460	554502	55450	10-25
SG75461	554512	55451	10-27
SG75462	554522	55452	10-29
SG75463	554532	55453	10-31
SG75464	554542	55454	10-33
SG75470	554502	55450	10-25
SG75471	554512	55451	10-27
SG75472	554522	55452	10-29
SG75473	554532	55453	10-31
SG75474	554542	55454	10-33
SG7805	78002	7800	6-347
SG7806	78002	7800	6-347
SG7808	78002	7800	6-347
SG7812	78002	7800	6-347
SG7815	78002	7800	6-347
SG7818	78002	7800	6-347
SG7820	78002	7800	6-347
SG7824	78002	7800	6-347
SG7805A	78002	7800	6-347
SG7806A	78002	7800	6-347

Bold = New Product, ****Bold Italic*** = Preliminary

For Current Product Index Fax, Request Document # ***1000***
For New Product Update Fax, Request Document # ***1001***

LINFINITY MICROELECTRONICS

INDEX & LIN DOCUMENT NUMBERS (cont'd.)

Part No.	LIN Document #'s Summary	Full	Page #
SG7808A	78002	7800	6-347
SG7812A	78002	7800	6-347
SG7815A	78002	7800	6-347
SG7818A	78002	7800	6-347
SG7820A	78002	7800	6-347
SG7824A	78002	7800	6-347
SG7905	79002	7900	6-349
SG7905.2	79002	7900	6-349
SG7908	79002	7900	6-349
SG7912	79002	7900	6-349
SG7915	79002	7900	6-349
SG7918	79002	7900	6-349
SG7920	79002	7900	6-349
SG7924	79002	7900	6-349
SG7905A	79002	7900	6-349
SG7905.2A	79002	7900	6-349
SG7908A	79002	7900	6-349
SG7912A	79002	7900	6-349
SG7915A	79002	7900	6-349
SG7918A	79002	7900	6-349
SG7920A	79002	7900	6-349
SG7924A	79002	7900	6-349
TL431	**4312**	**431**	8-51
TL431A	**4312**	**431**	8-51
TL431B	**4312**	**431**	8-51
UC1842A	**18402**	**1840**	6-357
UC1843A	**18402**	**1840**	6-357
UC1844A	**18402**	**1840**	6-357
UC1845A	**18402**	**1840**	6-357
UC2842A	**18402**	**1840**	6-357
UC2843A	**18402**	**1840**	6-357
UC2844A	**18402**	**1840**	6-357
UC2845A	**18402**	**1840**	6-357
UC3842A	**18402**	**1840**	6-357
UC3843A	**18402**	**1840**	6-357
UC3844A	**18402**	**1840**	6-357
UC3845A	**18402**	**1840**	6-357

Bold = New Product, ***Bold Italic*** = Preliminary

*For Current Product Index Fax, Request Document # **1000***
*For New Product Update Fax, Request Document # **1001***

LINFINITY MICROELECTRONICS

Part # Cross Reference

CROSS REFERENCE GUIDE

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Alpha			
AS2815	**1.5A Low Dropout Positive Adjustable Regulator**	**LX8386**	
AS2830	**3A Low Dropout Positive Adjustable Regulator**	**LX8385**	**LX8385-33 Fixed 3.3V Version**
AS2850	**5A Low Dropout Positive Adjustable Regulator**	**LX8384**	**LX8384-33 Fixed 3.3V Version**
Cherry			
CH1526	Dual Output Regulating PWM	SG1526	Direct Replacement
CH 1524	Dual Output Regulating PWM	SG1524	Direct Replacement
CH1524A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG1524B	Direct Replacement
CH1525A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG1525A	Direct Replacement
CS1527A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG1527A	Direct Replacement
CS1842	Current Mode PWM	SG1842	Direct Replacement
CS1843	Current Mode PWM	SG1843	Direct Replacement
CS2524	Dual output Regulating PWM	SG2524	Direct Replacement
CS2524A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG2524B	Direct Replacement
CS2525A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG2525A	Direct Replacement
CS2526	Dual Output Regulating PWM	SG2526	Direct Replacement
CS2527A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG2527A	Direct Replacement
CS2842A	Current Mode PWM (ind temp)	SG2842	Direct Replacement
CS2843A	Current Mode PWM (ind temp)	SG2843	Direct Replacement
CS2844	Current Mode PWM (ind temp)	SG2844	Direct Replacement
CS2845	Current Mode PWM (ind temp)	SG2845	Direct Replacement
CS3524	Dual Output Regulating PWM	SG3524	Direct Replacement
CS3524A	Improved Dual Output Regulating PWM, 1%V_{REF}	SG3524B	Direct Replacement
CS3842A	Current Mode PWM (comm temp)	SG3842	Direct Replacement
CS3843A	Current Mode PWM (comm temp)	SG3843	Direct Replacement
CS3844	Current Mode PWM (comm temp)	SG3844	Direct Replacement
CS3845	Current Mode PWM (comm temp)	SG3845	Direct Replacement
Dallas Semiconductor			
DS21S07	**SCSI Active Terminator, 9 Channel**	**LX5107**	
Fairchild / National			
UA109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
UA117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
UA1524	Dual Output Regulating PWM	SG1524	Direct Replacement
UA209	Positive Fixed Voltag Regulator, 5V	SG209	Direct Replacement
UA2524	Dual Output Regulating PWM	SG2524	Direct Replacement
UA309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
UA317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
UA3524	Dual Output Regulating PWM	SG3524	Direct Replacement
UA55450	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement
UA55452	Dual Peripheral NAND Driver	SG55452B	Direct Replacement
UA55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
UA75450	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement
UA75451	Dual Peripheral Positive AND Driver	SG75451B	Direct Replacement
UA75452	Dual Peripheral NAND Driver	SG75452B	Direct Replacement
UA75453	Dual Peripheral OR Driver	SG75453B	Direct Replacement
UA75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement

(continued next page)

LINFINITY MICROELECTRONICS

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Fairchild / National (continued)			
UA75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement
UA7805-M	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
UA7806-M	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
UA7808-M	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
UA7812-M	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
UA7815-M	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
UA7820-M	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
UA7824-M	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
UA7905-M	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
UA7908-M	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
UA7912-M	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
UA7915-M	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
UA9665	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2001	Direct Replacement
UA9666	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2002	Direct Replacement
UA9667	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2003	Direct Replacement
Linear Technology			
LM117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
LM117A	Positive Adj. Voltage Regulator - High Performance	SG117A	Direct Replacement
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
LM317A	Positive Adj. Voltage Regulator - High Performance	SG317A	Direct Replacement
LM337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
LT1083	**7.5A Low Dropout Positive Adjustable Regulator**	**LX8383**	**Direct Replace. / Lower Supply Voltage**
LT1084	**5A Low Dropout Positive Adjustable Regulator**	**LX8384**	**Direct Replace. / Lower Supply Voltage**
LT1085	**3A Low Dropout Positive Adjustable Regulator**	**LX8385**	**Direct Replace. / Lower Supply Voltage**
LT1086	**1.5A Low Dropout Positive Adjustable Regulator**	**LX8386**	**Direct Replace. / Lower Supply Voltage**
LT1242	**Low Start-Up Current, Current Mode PWM**	**LX1552**	**Different Pinout / No C.S. Blanking**
LT1243	**Low Start-Up Current, Current Mode PWM**	**LX1553**	**Different Pinout / No C.S. Blanking**
LT1244	**Low Start-Up Current, Current Mode PWM**	**LX1554**	**Different Pinout / No C.S. Blanking**
LT1245	**Low Start-Up Current, Current Mode PWM**	**LX1555**	**Different Pinout / No C.S. Blanking**
LT137A	Negative Adj. Voltage Regulator - High Performance	SG137A	Direct Replacement
LT1431	**Adjustable Shunt Reference (0.4%)**	**LX1431**	**Different Pinout / LX6431B available**
LT1524	Dual Output Regulating PWM	SG1524	Direct Replacement
LT1525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
LT1526	Dual Output Regulating PWM	SG1526	Direct Replacement
LT1527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
LT1584	**7A Low Dropout Positive Adjustable Regulator**	**LX8584**	**Direct Replacement**
LT1585	**4A Low Dropout Positive Adjustable Regulator**	**LX8585**	**Direct Replacement**
LT1587	**3A Low Dropout Positive Adjustable Regulator**	**LX8587**	**Direct Replacement**
LT1842	Current Mode PWM	SG1842	Direct Replacement
LT1843	Current Mode PWM	SG1843	Direct Replacement
LT2524	Dual Output Regulating PWM	SG2524	Direct Replacement
LT2524A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2524B	Direct Replacement
LT2526	Dual Output Regulating PWM	SG2526	Direct Replacement
LT337A	Negative Adj. Voltage Regulator - High Performance	SG337A	Direct Replacement

(continued next page)

LINFINITY MICROELECTRONICS

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Linear Tech (continued)			
LT3524	Dual Output Regulating PWM	SG3524	Direct Replacement
LT3525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3525A	Direct Replacement
LT3526	Dual Output Regulating PWM	SG3526	Direct Replacement
LT3527	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3527A	Direct Replacement
SG1524	Dual Output Regulating PWM	SG1524	Direct Replacement
SG1525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
SG1527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
SG2524	Dual Output Regulating PWM	SG2524	Direct Replacement
SG3524	Dual Output Regulating PWM	SG3524	Direct Replacement
SG3525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3525A	Direct Replacement
SG3527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3527A	Direct Replacement
UC1846	Current Mode PWM	SG1846	Direct Replacement
UC3846	Current Mode PWM	SG3846	Direct Replacement
Motorola			
LM109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
LM117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
LM140-15	Positive Fixed Voltage Regulator, 15V	SG140-15	Direct Replacement
LM140-18	Positive Fixed Voltage Regulator, 18V	SG140-18	Direct Replacement
LM140-24	Positive Fixed Voltage Regulator, 24V	SG140-24	Direct Replacement
LM209	Positive Fixed Voltage Regulator, 5V	SG209	Direct Replacement
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
LM237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
LM309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
LM337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
MAD1103F	16 Diode Array	SG5772F	Direct Replacement
MAD1104F	4 Common Anode, 4 Common Cathode Diode Array	SG5774F	Direct Replacement
MAD1108C	8 Straight Thru Diodes	SG6101J	Direct Replacement
MC1403	Precision 2.5V Reference	SG3503	Direct Replacement
MC1411	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2001	Direct Replacement
MC1412	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2002	Direct Replacement
MC1413	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2003	Direct Replacement
MC1416	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2004	Direct Replacement
MC1436	High Voltage Operational Amplifier	SG1436	Direct Replacement
MC1503	Precision 2.5V Reference	SG1503	Direct Replacement
MC1536	High Voltage Operational Amplifier	SG1536	Direct Replacement
MC1723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement
MC33064x-5	**5V Undervoltage Sensing Circuit (ind. temp.)**	**MC33064**	**Direct Replacement / LX7001I avail.**
MC33164x-3	**3V Undervoltage Sensing Circuit (ind. temp.)**	**MC33164-3**	**Direct Replacement**
MC33164x-5	**5V Undervoltage Sensing Circuit (ind. temp)**	**SG33164**	**Direct Replacement**
MC34064x-5	**5V Undervoltage Sensing Circuit (comm. temp.)**	**MC34064**	**Direct Replacement / LX7001C avail.**
MC34164x-3	**3V Undervoltage Sensing Circuit (comm. temp.)**	**MC34164-3**	**Direct Replacement**
MC34164x-5	**5V Undervoltage Sensing Circuit (comm. temp.)**	**SG34164**	**Direct Replacement**

(continued next page)

LINFINITY MICROELECTRONICS

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Motorola (continued)			
MC7805	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
MC7805A	Positive Fixed Voltage Regulator, 5V	SG7805A	Direct Replacement
MC7806	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
MC7806A	Positive Fixed Voltage Regulator, 6V	SG7806A	Direct Replacement
MC7808	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
MC7808A	Positive Fixed Voltage Regulator, 8V	SG7808A	Direct Replacement
MC7812	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
MC7812A	Positive Fixed Voltage Regulator, 12V	SG7812A	Direct Replacement
MC7815	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
MC7815A	Positive Fixed Voltage Regulator, 15V	SG7815A	Direct Replacement
MC7820	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
MC7820A	Positive Fixed Voltage Regulator, 20V	SG7820A	Direct Replacement
MC7824	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
MC7824A	Positive Fixed Voltage Regulator, 24V	SG7824A	Direct Replacement
MC7905	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
MC7905A	Negative Fixed Voltage Regulator, 5V	SG7905A	Direct Replacement
MC7905.2	Negative Fixed Voltage Regulator, 5.2V	SG7905.2	Direct Replacement
MC7905.2A	Negative Fixed Voltage Regulator, 5.2V	SG7905.2A	Direct Replacement
MC7908	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
MC7908A	Negative Fixed Voltage Regulator, 8V	SG7908A	Direct Replacement
MC7912	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
MC7912A	Negative Fixed Voltage Regulator, 12V	SG7912A	Direct Replacement
MC7915	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
MC7915A	Negative Fixed Voltage Regulator, 15V	SG7915A	Direct Replacement
MC7918	Negative Fixed Voltage Regulator, 18V	SG7918	Direct Replacement
MC7918A	Negative Fixed Voltage Regulator, 18V	SG7918A	Direct Replacement
MC7920	Negative Fixed Voltage Regulator, 20V	SG7920	Direct Replacement
MC7920A	Negative Fixed Voltage Regulator, 20V	SG7920A	Direct Replacement
SG1525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
SG1526	Dual Output Regulating PWM	SG1526	Direct Replacement
SG1527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
SG2525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2525A	Direct Replacement
SG2526	Dual Output Regulating PWM	SG2526	Direct Replacement
SG2527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2527A	Direct Replacement
SG3525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3525A	Direct Replacement
SG3526	Dual Output Regulating PWM	SG3526	Direct Replacement
TL431	**Adjustable Shunt Reference (2%)**	**TL431**	**Direct Replacement / LX6431 avail.**
TL431A	**Adjustable Shunt Reference (1%)**	**TL431A**	**Direct Replacement / LX6431A avail.**
TL431B	**Adjustable Shunt Reference (1%)**	**TL431A**	**Direct Replacement / LX6431A avail.**
UC2842A	**Current Mode PWM (ind. temp.)**	**SG2842**	**Direct Replacement**
UC2842B	**Current Mode PWM (ind. temp.)**	**UC2842A**	**Direct Replacement / LX1552I avail.**
UC2843A	**Current Mode PWM (ind. temp.)**	**SG2843**	**Direct Replacement**
UC2843B	**Current Mode PWM (ind. temp.)**	**UC2843A**	**Direct Replacement / LX1553I avail.**
UC2844A	**Current Mode PWM (ind. temp.)**	**SG2844**	**Direct Replacement**
UC2844B	**Current Mode PWM (ind. temp.)**	**UC2844A**	**Direct Replacement / LX1554I avail.**

(continued next page)

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Motorola (continued)			
UC2845A	**Current Mode PWM (ind. temp.)**	**SG2845**	**Direct Replacement**
UC2845B	**Current Mode PWM (ind. temp.)**	**UC2845A**	**Direct Replacement / LX1555I avail.**
UC3842A	**Current Mode PWM (comm. temp.)**	**SG3842**	**Direct Replacement**
UC3842B	**Current Mode PWM (comm. temp.)**	**UC3842A**	**Direct Replacement / LX1552C avail.**
UC3843A	**Current Mode PWM (comm. temp.)**	**SG3843**	**Direct Replacement**
UC3843B	**Current Mode PWM (comm. temp.)**	**UC3843A**	**Direct Replacement / LX1553C avail.**
UC3844A	**Current Mode PWM (comm. temp.)**	**SG3844**	**Direct Replacement**
UC3844B	**Current Mode PWM (comm. temp.)**	**UC3844A**	**Direct Replacement / LX1554C avail.**
UC3845A	**Current Mode PWM (comm. temp.)**	**SG3845**	**Direct Replacement**
UC3845B	**Current Mode PWM (comm. temp.)**	**UC3845A**	**Direct Replacement / LX1555C avail.**
National			
DS55325	Dual Source / Dual Sink Memory Driver	SG55325	Direct Replacement
DS55451	Dual Peripheral Positive AND Driver	SG55451	Direct Replacement
DS55452	Dual Peripheral NAND Driver	SG55452	Direct Replacement
DS55454	Dual Peripheral OR Driver	SG55454	Direct Replacement
DS55461	Dual Peripheral Positive AND Driver	SG55451	Direct Replacement
DS55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
DS55463	Dual Peripheral OR Driver	SG55463	Direct Replacement
DS55464	Dual Peripheral NOR Driver	SG55464	Direct Replacement
DS55470	Dual Peripheral Positive AND Driver	SG55470	Direct Replacement
DS55471	Dual Peripheral Positive AND Driver	SG55471	Direct Replacement
FSA2002M	8 Common Cathode Diode Array	SG5768F	Direct Replacement
FSA2003M	8 Common Anode Diode Array	SG5770F	Direct Replacement
FSA2500M	16 Diode Array	SG5772F	Direct Replacement
FSA2719M	8 Straight Thru Diodes	SG6101J	Direct Replacement
FSA2721M	7 Straight Thru Diodes	SG6100F	Direct Replacement
LM103-3.0	Voltage Reference, 3.0V	SG103-3.0	Direct Replacement
LM103-3.3	Voltage Reference, 3.3V	SG103-3.3	Direct Replacement
LM103-3.6	Voltage Reference, 3.6V	SG103-3.6	Direct Replacement
LM103-3.9	Voltage Reference, 3.9V	SG103-3.9	Direct Replacement
LM109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
LM117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
LM120-05	Negative Fixed Voltage Regulator, 5V	SG120-05	Direct Replacement
LM120-08	Negative Fixed Voltage Regulator, 8V	SG120-08	Direct Replacement
LM120-12	Negative Fixed Voltage Regulator, 12V	SG120-12	Direct Replacement
LM120-15	Negative Fixed Voltage Regulator, 15V	SG120-15	Direct Replacement
LM120-18	Negative Fixed Voltage Regulator, 18V	SG120-18	Direct Replacement
LM120-20	Negative Fixed Voltage Regulator, 20V	SG120-20	Direct Replacement
LM120-5.2	Negative Fixed Voltage Regulator, 5.2V	SG120-5.2	Direct Replacement
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM140-05	Positive Fixed Voltage Regulator, 5V	SG140-05	Direct Replacement
LM140-06	Positive Fixed Voltage Regulator, 6V	SG140-06	Direct Replacement
LM140-08	Positive Fixed Voltage Regulator, 8V	SG140-08	Direct Replacement
LM140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
LM140-15	Positive Fixed Voltage Regulator, 15V	SG140-15	Direct Replacement
LM140-18	Positive Fixed Voltage Regulator, 18V	SG140-18	Direct Replacement

(continued next page)

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
National (continued)			
LM140-20	Positive Fixed Voltage Regulator, 20V	SG140-20	Direct Replacement
LM143	High-Voltage Operational Amplifier	SG143	Direct Replacement
LM1524	Dual Output Regulating PWM	SG1524	Direct Replacement
LM209	Positive Fixed Voltage Regulator, 5V	SG209	Direct Replacement
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
LM237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
LM2524	Dual Output Regulating PWM	SG2524	Direct Replacement
LM2935	Dual Low Dropout Regulator	SG29055	Direct Replacement
LM2985	Dual Low Dropout Regulator	SG29085	Direct Replacement
LM309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
LM337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
LM3524	Dual Output Regulating PWM	SG3524	Direct Replacement
LM431A	**Adjustable Shunt Reference (2%)**	**TL431**	**Direct Replacement / LX6431 avail.**
LM723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement
MAD1105	8 Common Cathode Diode Array	SG5768	Direct Replacement
MAD1106	8 Common Anode Diode Array	SG5770	Direct Replacement
MAD1107	4 Common Anode, 4 Common Cathode Diode Array	SG5774	Direct Replacement
MAD1109	7 Straight Thru Diodes	SG6100	Direct Replacement
UA109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
UA117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
UA1524	Dual Output Regulating PWM	SG1524	Direct Replacement
UA2524	Dual Output Regulating PWM	SG2524	Direct Replacement
UA309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
UA317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
UA3524	Dual Output Regulating PWM	SG3524	Direct Replacement
UA55450	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement
UA55452	Dual Peripheral NAND Driver	SG55452B	Direct Replacement
UA55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
UA75450	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement
UA75451	Dual Peripheral Positive AND Driver	SG75451B	Direct Replacement
UA75452	Dual Peripheral NAND Driver	SG75452B	Direct Replacement
UA75453	Dual Peripheral OR Driver	SG75453B	Direct Replacement
UA75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement
UA75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement
UA7805-M	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
UA7806-M	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
UA7808-M	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
UA7812-M	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
UA7815-M	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
UA7820-M	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
UA7824-M	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
UA7905-M	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
UA7908-M	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
UA7912-M	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
UA7915-M	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement

(continued next page)

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
National (continued)			
UA9665	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2001	Direct Replacement
UA9666	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2002	Direct Replacement
UA9667	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2003	Direct Replacement
1N5768	8 Common Cathode Diode Array	1N5768	Direct Replacement
1N5770	8 Common Anode Diode Array	1N5770	Direct Replacement
1N5772	16 Diode Array	1N5772	Direct Replacement
Semtech			
EZ1083A	**7.5A Low Dropout Positive Adjustable Regulator**	**LX8383A**	
EZ1584	**7A Low Dropout Positive Adjustable Regulator**	**LX8584**	
EZ1584A	**7A Low Dropout Positive Adjustable Regulator**	**LX8584A**	
EZ1585	**4.6A Low Dropout Positive Adjustable Regulator**	**LX8585**	
EZ1585A	**4.6A Low Dropout Positive Adjustable Regulator**	**LX8585A**	
EZ1587	**3A Low Dropout Positive Adjustable Regulator**	**LX8587**	
EZ1587A	**3A Low Dropout Positive Adjustable Regulator**	**LX8587A**	
SC1083	**7.5A Low Dropout Positive Adjustable Regulator**	**LX8383**	**Minor Elec'l. Diff. / Dropout V, $V_{IN\,MAX}$**
SC1084	**5A Low Dropout Positive Adjustable Regulator**	**LX8384**	**Minor Elec'l. Diff. / Dropout V, $V_{IN\,MAX}$**
SC1085	**3A Low Dropout Positive Adjustable Regulator**	**LX8385**	**Minor Elec'l. Diff. / Dropout V, $V_{IN\,MAX}$**
SC1086	**1.5A Low Dropout Positive Adjustable Regulator**	**LX8386**	**Minor Elec'l. Diff. / Dropout V, $V_{IN\,MAX}$**
SGS			
L272	Dual Power Operational Amplifier	SG3272	Direct Replacement
L2722	Dual Power Operational Amplifier	SG3272	Direct Replacement
L2726	Dual Power Operational Amplifier	SG3272	Direct Replacement
L601	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2821	Direct Replacement
L602	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2822	Direct Replacement
L603	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2823	Direct Replacement
L604	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2824	Direct Replacement
L7805	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
L7806	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
L7808	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
L7812	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
L7815	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
L7820	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
L7824	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
L7905	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
L7905.2	Negative Fixed Voltage Regulator, 5.2V	SG7905.2	Direct Replacement
L7908	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
L7912	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
L7915	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
L7918	Negative Fixed Voltage Regulator, 18V	SG7918	Direct Replacement
L7920	Negative Fixed Voltage Regulator, 20V	SG7920	Direct Replacement
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
LM723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement
ULN2801A	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2801	Direct Replacement
ULN2802A	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2802	Direct Replacement
ULN2803A	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2803	Direct Replacement
ULN2804A	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2804	Direct Replacement

(continued next page)

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Sprague / Allegro			
UDN2935	Half-Bridge Driver	SG3635	Direct Replacement
ULN8125A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3525A	Direct Replacement
ULN8126	Dual Output Regulating PWM	SG3526	Direct Replacement
ULN8127A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3527A	Direct Replacement
ULQ8124	Dual Output Regulating PWM	SG2524	Direct Replacement
ULQ8125	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2525A	Direct Replacement
ULQ8126	Dual Output Regulating PWM	SG2526	Direct Replacement
ULQ8127	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2527A	Direct Replacement
ULS2001	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2001	Direct Replacement
ULS2002	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2002	Direct Replacement
ULS2003	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2003	Direct Replacement
ULS2004	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2004	Direct Replacement
ULS2011	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2011	Direct Replacement
ULS2012	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2012	Direct Replacement
ULS2013	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2013	Direct Replacement
ULS2014	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2014	Direct Replacement
ULS2021	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2021	Direct Replacement
ULS2022	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2022	Direct Replacement
ULS2023	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2023	Direct Replacement
ULS2024	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2024	Direct Replacement
ULS2801	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2801	Direct Replacement
ULS2802	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2802	Direct Replacement
ULS2803	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2803	Direct Replacement
ULS2804	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.5A	SG2804	Direct Replacement
ULS2811	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2811	Direct Replacement
ULS2812	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2812	Direct Replacement
ULS2813	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2813	Direct Replacement
ULS2814	Medium Current Driver Array, V_{CE} = 50V, I_{OUT} = 0.6A	SG2814	Direct Replacement
ULS2821	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2821	Direct Replacement
ULS2822	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2822	Direct Replacement
ULS2823	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2823	Direct Replacement
ULS2824	Medium Current Driver Array, V_{CE} = 95V, I_{OUT} = 0.5A	SG2824	Direct Replacement
ULS8124	Dual Output Regulating PWM	SG1524	Direct Replacement
ULS8125A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
ULS8126H	Dual Output Regulating PWM	SG1526	Direct Replacement
ULS8127A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
Texas Instruments			
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
LM237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
SG1524	Dual Output Regulating PWM	SG1524	Direct Replacement
SG2524	Dual Output Regulating PWM	SG2524	Direct Replacement
SN75325	Dual Source / Dual Sink Memory Driver	SG75325	Direct Replacement
SN75326	Quad Sink Memory Driver	SG75326	Direct Replacement
SN75327	Quad Source Memory Driver	SG75327	Direct Replacement
SN75450B	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement
SN75451B	Dual Peripheral Positive AND Driver	SG75451B	Direct Replacement

(continued next page)

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Texas Instruments (continued)			
SN75452B	Dual Peripheral NAND Driver	SG75452B	Direct Replacement
SN75453B	Dual Peripheral OR Driver	SG75453B	Direct Replacement
SN75454B	Dual Peripheral NOR Driver	SG75454B	Direct Replacement
SN75460	Dual Peripheral Positive AND Driver	SG75460	Direct Replacement
SN75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement
SN75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement
SN75463	Dual Peripheral OR Driver	SG75463	Direct Replacement
SN75464	Dual Peripheral NOR Driver	SG75464	Direct Replacement
SN75470	Dual Peripheral Positive AND Driver	SG75470	Direct Replacement
SN75471	Dual Peripheral Positive AND Driver	SG75471	Direct Replacement
SN75472	Dual Peripheral NAND Driver	SG75472	Direct Replacement
SN75473	Dual Peripheral OR Driver	SG75473	Direct Replacement
SN75474	Dual Peripheral NOR Driver	SG75474	Direct Replacement
SNJ55325	Dual Source / Dual Sink Memory Driver	SG55325	Direct Replacement
SNJ55326	Quad Sink Memory Driver	SG55326	Direct Replacement
SNJ55450B	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement
SNJ55451B	Dual Peripheral Positive AND Driver	SG55451B	Direct Replacement
SNJ55452B	Dual Peripheral NAND Driver	SG55452B	Direct Replacement
SNJ55453B	Dual Peripheral OR Driver	SG55453B	Direct Replacement
SNJ55454B	Dual Peripheral NOR Driver	SG55454B	Direct Replacement
SNJ55460	Dual Peripheral Positive AND Driver	SG55460	Direct Replacement
SNJ55461	Dual Peripheral Positive AND Driver	SG554612	Direct Replacement
SNJ55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
SNJ55463	Dual Peripheral OR Driver	SG55463	Direct Replacement
SNJ55464	Dual Peripheral NOR Driver	SG55464	Direct Replacement
SNJ55470	Dual Peripheral Positive AND Driver	SG55470	Direct Replacement
SNJ55471	Dual Peripheral Positive AND Driver	SG55471	Direct Replacement
SNJ55472	Dual Peripheral NAND Driver	SG55472	Direct Replacement
SNJ55473	Dual Peripheral OR Driver	SG55473	Direct Replacement
SNJ55474	Dual Peripheral NOR Driver	SG55474	Direct Replacement
TL117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
TL1525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
TL1527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
TL2218-285	**SCSI Active Terminator, 9-Channel**	**LX5219**	**Direct Replacement / Improved ICC**
TL2525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2525A	Direct Replacement
TL2527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2527A	Direct Replacement
TL1431	**Adjustable Shunt Reference (0.4%)**	**TL431B**	**Direct Replacement / LX6431B avail.**
TL431	**Adjustable Shunt Reference (2%)**	**TL431**	**Direct Replacement / LX6431 avail.**
TL431A	**Adjustable Shunt Reference (1%)**	**TL431A**	**Direct Replacement / LX6431A avail.**

(continued next page)

LINFINITY MICROELECTRONICS

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Unitrode			
PIC600	Switching Regulator Power Output Stages	SM600	Direct Replacement
PIC601	Switching Regulator Power Output Stages	SM601	Direct Replacement
PIC602	Switching Regulator Power Output Stages	SM602	Direct Replacement
PIC610	Switching Regulator Power Output Stages	SM610	Direct Replacement
PIC611	Switching Regulator Power Output Stages	SM611	Direct Replacement
PIC612	Switching Regulator Power Output Stages	SM612	Direct Replacement
PIC625	Switching Regulator Power Output Stages	SM625	Direct Replacement
PIC626	Switching Regulator Power Output Stages	SM626	Direct Replacement
PIC627	Switching Regulator Power Output Stages	SM627	Direct Replacement
PIC645	Switching Regulator Power Output Stages	SM645	Direct Replacement
PIC646	Switching Regulator Power Output Stages	SM646	Direct Replacement
PIC647	Switching Regulator Power Output Stages	SM647	Direct Replacement
UC117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
UC120-05	Negative Fixed Voltage Regulator, 5V	SG120-05	Direct Replacement
UC120-12	Negative Fixed Voltage Regulator, 12V	SG120-12	Direct Replacement
UC120-15	Negative Fixed Voltage Regulator, 15V	SG120-15	Direct Replacement
UC137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
UC140-05	Positive Fixed Voltage Regulator, 5V	SG140-05	Direct Replacement
UC140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
UC140-15	Positive Fixed Voltage Regulator, 15V	SG140-15	Direct Replacement
UC1524	Dual Output Regulating PWM	SG1524	Direct Replacement
UC1524A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1524B	Direct Replacement
UC1525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1525A	Direct Replacement
UC1526	Dual Output Regulating PWM	SG1526	Direct Replacement
UC1526A	Improved Dual Output Regulating PWM	SG1526B	Direct Replacement
UC1527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG1527A	Direct Replacement
UC1543	Precision Power Supply Output Supervisory Circuit	SG1543	Direct Replacement
UC1544	Precision Power Supply Output Supervisory Circuit	SG1544	Direct Replacement
UC1823	**High Speed, Current Mode PWM**	**LX1823**	**Minor Elec'l. Differences / Frequency**
UC1842	Current Mode PWM (mil. temp.)	SG1842	Direct Replacement
UC1842A	**Current Mode PWM (mil. temp.)**	**UC1842A**	**Direct Replacement**
UC1843	Current Mode PWM (mil. temp.)	SG1843	Direct Replacement
UC1843A	**Current Mode PWM (mil. temp.)**	**UC1843A**	**Direct Replacement**
UC1844	Current Mode PWM (mil. temp.)	SG1844	Direct Replacement
UC1844A	**Current Mode PWM (mil. temp.)**	**UC1844A**	**Direct Replacement**
UC1845	Current Mode PWM (mil. temp.)	SG1845	Direct Replacement
UC1845A	**Current Mode PWM (mil. temp.)**	**UC1845A**	**Direct Replacement**
UC1846	Current Mode PWM (mil. temp.)	SG1846	Direct Replacement
UC217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
UC237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
UC2524	Dual Output Regulating PWM	SG2524	Direct Replacement
UC2524A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2524B	Direct Replacement
UC2525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2525A	Direct Replacement
UC2526	Dual Output Regulating PWM	SG2526	Direct Replacement
UC2526A	Improved Dual Output Regulating PWM	SG2526B	Direct Replacement
UC2527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG2527A	Direct Replacement

(continued next page)

LINFINITY MICROELECTRONICS

Part # Cross Reference

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Unitrode (continued)			
UC2540	Off Line Start Up Controller With SCR Driver	SG2540	Direct Replacement
UC2543	Precision Power Supply Output Supervisory Circuit	SG2543	Direct Replacement
UC2544	Precision Power Supply Output Supervisory Circuit	SG2544	Direct Replacement
UC2842	Current Mode PWM (ind. temp.)	SG2842	Direct Replacement
UC2842A	**Current Mode PWM (ind. temp.)**	**UC2842A**	**Direct Replacement**
UC2843	Current Mode PWM (ind. temp.)	SG2843	Direct Replacement
UC2843A	**Current Mode PWM (ind. temp.)**	**UC2843A**	**Direct Replacement**
UC2844	Current Mode PWM (ind. temp.)	SG2844	Direct Replacement
UC2844A	**Current Mode PWM (ind. temp.)**	**UC2844A**	**Direct Replacement**
UC2845	Current Mode PWM (ind. temp.)	SG2845	Direct Replacement
UC2845A	**Current Mode PWM (ind. temp.)**	**UC2845A**	**Direct Replacement**
UC2846	Current Mode PWM (ind. temp.)	SG2846	Direct Replacement
UC317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
UC337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
UC3524	Dual Output Regulating PWM	SG3524	Direct Replacement
UC3525A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3525A	Direct Replacement
UC3526	Dual Output Regulating PWM	SG3526	Direct Replacement
UC3526A	Improved Dual Output Regulating PWM	SG3526B	Direct Replacement
UC3527A	Improved Dual Output Regulating PWM, 1% V_{REF}	SG3527A	Direct Replacement
UC3543	Precision Power Supply Output Supervisory Circuit	SG3543	Direct Replacement
UC3544	Precision Power Supply Output Supervisory Circuit	SG3544	Direct Replacement
UC3717	Stepper Motor Driver	SG3718	Direct Replacement
UC3842	Current Mode PWM (comm. temp.)	SG3842	Direct Replacement
UC3842A	**Current Mode PWM (comm. temp.)**	**UC3842A**	**Direct Replacement**
UC3843	Current Mode PWM (comm. temp.)	SG3843	Direct Replacement
UC3843A	**Current Mode PWM (comm. temp.)**	**UC3843A**	**Direct Replacement**
UC3844	Current Mode PWM (comm. temp.)	SG3844	Direct Replacement
UC3844A	**Current Mode PWM (comm. temp.)**	**UC3844A**	**Direct Replacement**
UC3845	Current Mode PWM (comm. temp.)	SG3845	Direct Replacement
UC3845A	**Current Mode PWM (comm. temp.)**	**UC3845A**	**Direct Replacement**
UC3846	Current Mode PWM (comm. temp.)	SG3846	Direct Replacement
UC5601	**SCSI Active Terminator, 18-Channel**	**LX5202**	**Direct Replacement / Improved ICC**
UC5602	**SCSI Active Terminator, 18-Channel**	**LX5202**	**Direct Replacement / Improved ICC**
UC5603	**SCSI Active Terminator, 9-Channel**	**LX5203**	**Direct Replacement / Improved ICC**
UC5608	**SCSI Active Terminator, 18-Channel**	**LX5208**	**Direct Replacement / Improved ICC**
UC5609	**SCSI Active Terminator, 18-Channel**	**LX5208**	**Direct Replacement / Improved ICC**
UC5610	**SCSI Active Terminator, 18-Channel**	**LX5207**	
UC5612	**SCSI Active Terminator, 9-Channel**	**LX5212**	
UCC5614	**SCSI Active Terminator, 9-Channel**	**LX5213**	**Direct Replacement / Improved ICC**
UC7805	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
UC7805A	Positive Fixed Voltage Regulator, 5V	SG7805A	Direct Replacement
UC7812	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
UC7812A	Positive Fixed Voltage Regulator, 12V	SG7812A	Direct Replacement
UC7812A	Positive Fixed Voltage Regulator, 12V	SG7812A	Direct Replacement
UC7815	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
UC7815A	Positive Fixed Voltage Regulator, 15V	SG7815A	Direct Replacement

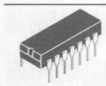
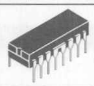
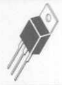
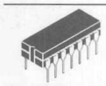
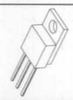
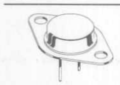
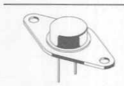
(continued next page)

CROSS REFERENCE GUIDE (continued)

Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Unitrode (continued)			
UC7905	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
UC7905A	Negative Fixed Voltage Regulator, 5V	SG7905A	Direct Replacement
UC7912	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
UC7912A	Negative Fixed Voltage Regulator, 12V	SG7912A	Direct Replacement
UC7915	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
UC7915A	Negative Fixed Voltage Regulator, 15V	SG7915A	Direct Replacement

Package Cross-Reference

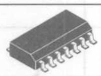
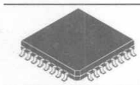
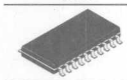
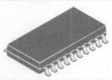
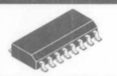
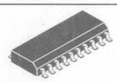
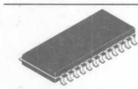
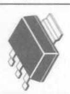
THRU-HOLE PACKAGES

Thru-Hole Packages		LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instruments	Unitrode
STANDARD PLASTIC										
	DIP *8 - Pin*	**M**	N	N8	P1	N, N8	N	M	P	N
	DIP *14, 16, 18, 20, & 24 - Pin*	**N**	N	N	P2	N, N14	N	A	N,NE,NG	N
	DIP *16 - Pin (Batwing)*	**W**	-	-	-	-	-	B	-	-
	TO-92 *3 - Pin*	**LP**	-	Z	P	Z	-	-	LP	-
POWER PLASTIC										
	TO-220 *3 & 5 - Pin*	**P**	-	T	T	T	U	Z	KC	T
	TO-247 *3 - Pin*	**V**	-	P	-	-	-	-	-	-
CERAMIC										
	DIP *8 - Pin*	**Y**	J	J8	U	J, J8	FE	-	JG	J
	DIP *14, 16 (TO-116), & 18 - Pin*	**J**	J	J	L	J, J14	F	R	J	J
	Hermetic TO-257 *3 - Pin*	**IG**	-	-	-	-	-	-	-	IG
METAL CAN										
	*2 (TO-46), 3 (TO-52) - Pin*	**Z**	-	H	-	H	-	-	-	-
	*3 (TO-39), 8 (TO-99), 10 (TO-96, TO-100), & 12 (TO-101) - Pin*	**T**	-	H	G, H	H	H	-	-	H
	TO-3 *3 - Pin*	**K**	-	K	K	K	-	V	-	K
	TO-66 *3, 5, & 9 - Pin*	**R**	-	-	R	-	-	-	-	-

LINFINITY MICROELECTRONICS

Package Cross-Reference

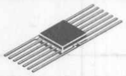
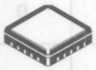
SURFACE-MOUNT PACKAGES

Surface Mount Packages		LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instruments	Unitrode
STANDARD PLASTIC										
	SOIC *8 - Pin*	**DM**	-	S8	D	M	D	L	D	-
	SOIC *14 & 16 - Pin*	**D**	-	S	D	M	D	L	D	D
	SOWB *16, 18, & 20 - Pin*	**DW**	-	S	D	M	DW	LW	DW	D
	PLCC *20 & 28 - Pin*	**Q**	FN	-	FN	V	-	EP	FN	Q
	TQFP *32 & 48 - Pin*	**TF**	-	-	-	-	-	-	-	-
	TSSOP *20 - Pin*	**PW**	-	F	-	-	-	-	PW	-
	SSOP *20, 24, 28, 36 - Pin*	**DB**	-	G	-	-	-	-	DB	-
	SOT-89 *3 - Pin*	**PK**	-	-	-	-	-	-	PK	-
POWER PLASTIC										
	SOIC Power *16 - Pin*	**DP**	-	-	-	-	-	-	-	DP
	SOWB Power *20 & 28 - Pin*	**DWP**	-	-	-	-	-	-	-	DWP
	TSSOP Power *24 - Pin*	**PWP**	-	-	-	-	-	-	-	PWP
	TO-263AA *3 & 5 - Pin*	**DD**	-	M	-	-	-	-	-	-
	TO-223 *3 - Pin*	**ST**	-	ST	-	-	-	-	-	-

LINFINITY MICROELECTRONICS

Package Cross-Reference

SURFACE MOUNT PACKAGES

Surface Mount Packages		LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instruments	Unitrode
CERAMIC										
	Flatpack *10, 14, 16, 20 & 24 - Pin*	**F**	-	W	F	F	-	-	W	-
	LCC *20 - Pin*	**L**	-	L	FN	E	G	EK	FN	L

LINFINITY MICROELECTRONICS

Product Identification

PART NUMBER CODING

PART NUMBER EXAMPLE (LINFINITY IDENTIFICATIONS)

LX	3000	B	C	DP	JAN
LXM	1500				
PLX	4000		I	N	

Product

LX	Linfinity Production Status
LXM	Linfinity Module
PLX	Linfinity Prototype Status
ELX	Linfinity Experimental Status
SG	Silicon General Linear Integrated Circuit

Electrical Grades

(optional)

A or B Improved Performance

Processing Level

(optional)

(SPS No.)	4 or 5 digit in-house number for Spec. Control Drawings
883B	MIL-STD-883B
JAN	MIL-M-38510 (Integrated Circuits)
SMD	Standardized Military Drawing (DESC)
JAN	MIL-S-19500 (Descrete Component)

PART NUMBER EXAMPLE (SILICON GENERAL IDENTIFICATIONS)

SG	1524		J	883B
SG	2524		N	
SG	3524	A	N	

LINFINITY

Temperature Ranges

C	Commercial	0°C to 70°C
I	Industrial	-25°C to 85°C
Q	Automotive	-40°C to 125°C
M	Military	-55°C to 125°C

Package Types

M	Plastic DIL (8 pins)
N	Plastic DIL (14,16,18,20,24 pins)
W	Plastic Batwing DIL (16 pins)
LP††	TO-92 (3 pins)
P	Plastic TO-220 (3,5 pins)
V	Plastic TO-247 SIP (3 pins)
Y	Ceramic DIL (8 pins)
J	Ceramic DIL (14,16,18 pins)
IG	TO-257 (isolated hermetic TO-220) (3 pins)
Z	TO-46 Metal Can (2 pins) & TO-52 Metal Can (3 pins)
T	TO-5 Metal Can (3,8,10,12 pins)
K	TO-3 Metal Can (3,4 pins)
R	TO-66 Metal Can (3,4,5,9 pins)
DM†	Plastic SOIC (8 pins)
D†	Plastic SOIC (14,16 pins)
DW†	Plastic SOWB (16,18,20 pins)
Q†	PLCC - Plastic Leaded Chip Carrier (20,28 pins)
TF	TQFP - Thin Quad Flat Pack (32,48 pins)
PW†	TSSOP - Thin Small Outline Package (20 pins)
DB†	SSOP - Shrink Small Outline Package (20,24,28,36 pins)
PK†	SOT-89 (3-pins)
DP†	Plastic SOIC Power (16 pins)
DWP†	Plastic SOWB Power (20,28 pins)
PWP†	Power TSSOP - Thin Small Outline Pkg. (20,24 pins)
DD†	Plastic TO-263AA (3,5 pins)
ST†	SOT-223 (3 pins)
F	Ceramic Flatpack (10,14,16,20,24 pins)
L	LCC - Ceramic Leadless Chip Carrier (20 pins)

† = Package is available in Tape & Reel. Add the letter "T" after package type. See page 13-18 for additional surface-mount tape & reel information.

†† = TO-92 (LP) package is available in both tape & reel *and* ammo pack. See page 13-20 for odering details and additional information.

SILICON GENERAL

Temperature Ranges

1	Military	-55°C to 125°C
2	Industrial	-25°C to 85°C
3	Commercial	0°C to 70°C

LINFINITY MICROELECTRONICS

Notes

Thumb Index

LINFINITY MICROELECTRONICS

Section Index

POWER SUPPLY CIRCUITS

PWM IC Controllers

Low Dropout Positive Voltage Regulators

Standard Linear Voltage Regulators

Bold = New Product, ***Bold Italic*** = Preliminary

LINFINITY MICROELECTRONICS

Standard Linear Voltage Regulators (cont'd.)

Supervisors

MOSFET Drivers

Support Functions

Switching Regulator Output Stages

Modular Products

Bold = New Product, ****Bold Italic*** = Preliminary

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Selection Guide

POWER SUPPLY CIRCUITS

PWM IC Controllers

PERFORMANCE CHARACTERISTICS

DEVICE TYPE: Voltage Mode PWM's	PAGE #	Voltage Reference (%)	Soft Start	PWM Latch	Under-Voltage Lockout	Pulse-by-Pulse Current Limiting	Shutdown Terminal	Output Transistor Rating (V_{CE}, Peak Current)	Maximum Oscillator Frequency	Uncommitted Outputs	Number of Outputs	Totem Pole Outputs	Separate Oscillator Sync Terminal	Adjustable Deadtime Control	Double Pulse Suppression	Max. Duty Cycle / Output	PACKAGES
SG1524/2524/3524	6-239	±4					✓	40V 100mA	300KHz	✓	2		✓			<50%	J, N, D, L
SG1524B/2524B/3524B	6-241	±1		✓	✓	✓	✓	60V 200mA	500KHz	✓	2		✓		✓	<50%	J, N, DW, L
SG1525A/2525A/3525A	6-243	±1	✓	✓	✓		✓	35V 0.4A	500KHz		2	✓	✓	✓		<50%	J, N, DW, L
SG1526/2526/3526	6-245	±1	✓	✓	✓	✓	✓	35V 0.4A	400KHz		2	✓	✓	✓	✓	<50%	J, N, DW, L
SG1526B/2526B/3526B	6-247	±1	✓	✓	✓	✓	✓	35V 0.4A	500KHz		2	✓	✓	✓	✓	<50%	J, N, DW, L
SG1527A/2527A/3527A	6-243	±1	✓	✓	✓		✓	35V 0.4A	500KHz		2	✓	✓	✓		<50%	J, N, DW, L
SG1529/2529/3529	6-249	±1		✓	✓	✓	✓	60V 200mA	500KHz	✓	2		✓		✓	<50%	J, N, DW

DEVICE TYPE: LX1562/1563

DESCRIPTION: POWER FACTOR CONTROLLER.

PAGE # 6-33

KEY FEATURES

1. Internal start-up current.
2. Internal current sense blanking.
3. Improved micropower start-up current (300µA max.).
4. Clamped E.A. output for lower turn-on overshoot.
5. Multiplier clamp limits maximum input current.
6. Internal over-voltage protection replaces built in C.S. offset.
7. PWM output clamp limits MOSFET gate drive voltage.

PACKAGES: M, DM, Y

DEVICE TYPE: LX1570/1571

DESCRIPTION: PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER.

PAGE # 6-59

KEY FEATURES

1. Replaces costly mag-amp cores with a low on-resistance MOSFET.
2. **Look-Ahead Switching™** ensures switch turn on before the AC input, to achieve 100% energy transfer.
3. Lower overall system cost.
4. Lower peak current stress on the primary switch.
5. Easy short-circuit protection.

PACKAGES: M, DM, Y

DEVICE TYPE: SG3561A

DESCRIPTION: POWER FACTOR CONTROLLER.

PAGE # 6-325

KEY FEATURES

1. Optimized for flourescent lamp ballast.
2. Micro-power start-up mode.
3. Low operating current consumption.
4. Internal 5% reference.
5. Totem pole output stage.
6. Automatic current limiting of boost stage.
7. Optimized for < 150W.

PACKAGES: M, N, DM

LINFINITY MICROELECTRONICS

PWM IC Controllers

Performance Characteristics

Device Type: Current Mode PWM's	Page #	µPower Start-Up Current (µA max.)	Soft Start	UVLO Hysteresis (V)	Start-Up Voltage (V)	Pulse-by-Pulse Current Limiting	Shutdown Terminal	Output Transistor Rating (V_{CE}, Peak Current)	Maximum Oscillator Frequency	Max. Oscillator Initial Accuracy	Number of Outputs	Totem Pole Outputs	Separate Oscillator Sync Terminal	Max. Duty Cycle / Output	Packages
LX1552	6-15	250		6	16	✓		30V 1A	500KHz		1	✓		<100%	M, DM, D Y, PW
LX1553	6-15	250		1	9	✓		30V 1A	500KHz		1	✓		<100%	M, DM, D Y, PW
LX1554	6-15	250		6	16	✓		30V 1A	500KHz		1	✓		<50%	M, DM, D Y, PW
LX1555	6-15	250		1	9	✓		30V 1A	500KHz		1	✓		<50%	M, DM, D Y, PW
UC1842A/2842A/3842A	6-357	500		6	16	✓		30V 1A	500KHz		1	✓		<100%	M, DM D, Y
UC1843A/2843A/3843A	6-357	500		1	9	✓		30V 1A	500KHz		1	✓		<100%	M, DM D, Y
UC1844A/2844A/3844A	6-357	500		6	16	✓		30V 1A	500KHz		1	✓		<100%	M, DM D, Y
UC1845A/2845A/3845A	6-357	500		1	9	✓		30V 1A	500KHz		1	✓		<100%	M, DM D, Y
SG1842/2842/3842	6-275	1000		6	16	✓		30V 1A	500KHz	✓	1	✓		<100%	J, N, Y, M D, DM, F, L
SG1843/2843/3843	6-275	1000		1	9	✓		35V 1A	500KHz	✓	1	✓		<100%	J, N, Y, M D, DM, F, L
SG1844/2844/3844	6-289	1000		6	16	✓		35V 1A	500KHz	✓	1	✓		<50%	J, N, Y, M D, DM, F, L
SG1845/2845/3845	6-289	1000		1	9	✓		35V 1A	500KHz	✓	1	✓		<50%	J, N, Y, M D, DM, F, L
LX1823	6-71	1000	✓	1	9	✓	✓	30V 1.5A	1.5MHz	✓	1	✓	✓	<100%	J, N, DW Q, L
SG1825C/2825C/3825C	6-267	1000	✓	1	9	✓	✓	30V 1.5A	2MHz	✓	2	✓	✓	<50%	J, N, DW Q, L
SG1846/2846/3846	6-301	n/a	✓	0.4	8	✓	✓	40V 500mA	500KHz	✓	2	✓	✓	<50%	J, N, DW F, L

LINFINITY MICROELECTRONICS

Selection Guide

POWER SUPPLY CIRCUITS

Low Dropout Positive Voltage Regulators
ADJUSTABLE

Device Type	Page #	Output Current	Maximum Drop Out (V)	Maximum Input Voltage (V)	Output Voltage Range (V)	Packages
		Performance Characteristics				
LX8582A	6-137	8.5A	1.3	10	1.25 to 8	P, V
LX8383A	6-103	7.5A	1.3	10	1.25 to 8	P, V
LX8383			1.5	10	1.25 to 8	
LX8584A	6-139	7A	1.2	10	1.25 to 8	P, V
LX8584/8584B			1.4	10	1.25 to 8	
LX8586A	6-143	6A	1.1	10	1.25 to 8	P, V
LX8586			1.3	10	1.25 to 8	
LX8554	6-135	5A	1.0	10	1.25 to 8	P, DD
LX8384A	6-111		1.3	10	1.25 to 8	P, DD, V
LX8384			1.5	10	1.25 to 8	
LX8585A	6-141	4.6A	1.2	10	1.25 to 8	P, DD
LX8585			1.4	10	1.25 to 8	
LX8587A	6-145	3A	1.2	10	1.25 to 8	P, DD
LX8587			1.3	10	1.25 to 8	
LX8385	6-119		1.5	20	1.25 to 18	P, DD
LX8386	6-127	1.5A	1.5	20	1.25 to 18	P, DD
LX8941	6-155	1A	0.8	26	1.25 to 25	P, DD
LX8020/8020A	6-99	200mA	0.2 Typ.	10	1.25 to 8	LP, DM

LINFINITY MICROELECTRONICS

Selection Guide

POWER SUPPLY CIRCUITS

Low Dropout Positive Voltage Regulators
FIXED

Device Type	Page #	Output Current	Maximum Drop Out (V)	Maximum Input Voltage (V)	Output Voltage (V)	Packages
		PERFORMANCE CHARACTERISTICS				
LX8940	6-151	1A	0.8	24	5	ST
SG29055/55A	6-303	0.5A	0.6	26	5 / 5	P
SG29085/85A	6-305		0.6	26	8 / 5	
SG29125/125A	6-307		0.6	26	12 / 5	
LX5285	6-81	800mA	1.1		2.85	P
LX8020-28/A-28	6-99	200mA	0.2 Typ.	10	2.85	LP, DM
LX8020-30/A-30	6-99		0.2 Typ.	10	3.0	
LX8020-33/A-33	6-99		0.2 Typ.	10	3.3	
LX8020-48/A-48	6-99		0.2 Typ.	10	4.8	
LX8020-50/A-50	6-99		0.2 Typ.	10	5.0	

Selection Guide

POWER SUPPLY CIRCUITS

Standard Linear Voltage Regulators

Device Type	Page #	Output Current	Polarity	Fixed	Adjust.	Max. Input Voltage	Output Voltage (V)	Packages
			Performance Characteristics					
SG117/117A	6-229	1.5A°	Positive		✓	35V	1.2V to 37V	K, R, IG*, L
SG140/140A	6-237		Positive	✓		35V	5, 6, 8, 12, 15 18, 20, 24V	
SG7800/7800A	6-347			✓				
SG109	6-227		Positive	✓		35V	5V	K, R, IG
SGR117A	6-231		Positive		✓	35V	-1.2V to -37V	
SG137/137A	6-235		Negative		✓	35V	-1.2V to -37V	K, R, IG, L
SG120	6-233		Negative	✓		35V	-5, -5.2, -8, -12, 15, -18, -20V	
SG7900/7900A	6-349			✓				
SGR117A	6-231	0.5A	Positive		✓	35V	1.2V to 37V	T
SG7800/7800A	6-347		Positive	✓		35V	5, 6, 8, 12, 15, 18, 20, 24	
SG109	6-227		Positive	✓		35V	5V	
SG137/137A	6-235		Negative		✓	35V	-1.2 to -37V	
SG120	6-233		Negative	✓		35V	-5, -5.2, -8, -12, -15, -18, -20V	
SG7900/7900A	6-349			✓				
SG1532	6-251	0.1A	Positive		✓	50V	2V to 38V	K, R, IG
SG723	6-345		Positive		✓	50V	2V to 38V	J, T, F, L

* SG140A available in "IG" package only.

LINFINITY MICROELECTRONICS

Supervisory Circuits

Device Type	Description	Key Features	Packages
LX7001	**TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT.** PAGE # 6-85	1. Fully characterized, transient immune input stage. 2. Monitors 5V supplies. (V_{TRIP} = 4.6V typ.) 3. Outputs fully defined at V_{CC} = 1V. 4. Ultra-low supply current. (500µA max. over temp.) 5. µP Reset function programmable with 1 external resistor and capacitor. 6. Comparator hysteresis prevents output oscillation. 7. Pin-to-pin compatible with Motorola MC34064/34164.	DM, LP, PK, Y
LX7705	**5V SUPPLY VOLTAGE SUPERVISOR with REFERENCE.** PAGE # 6-95	1. Monitors 5V supplies. 2. Outputs fully defined at V_{CC} = 1V. 3. Improved output leakage < 10µA. 4. $\overline{RESET}$ TF = 15ns typical. Low 1.4mA typical I_{CC}. 5. 2.5V external 30mA reference. 6. Programmable reset delay. 7. True / Complimentary outputs. 8. Eliminates need for capacitor on reference pin.	M, DM
MC33064/34064	**UNDERVOLTAGE SENSING CIRCUIT.** PAGE # 6-207	1. Monitors 5V supplies. (V_{TRIP} = 4.6V typ.) 2. Outputs fully defined at V_{IN} = 1V. 3. Glitch-free supply current during switching. 4. Ultra-low supply current. (500µA max.) 5. µP Reset function programmable with 1 external resistor and capacitor. 6. Comparator hysteresis prevents output oscillation. 7. Pin-to-pin compatible with Motorola MC34064/34164.	DM, LP, PK
MC33164-3/34164-3	**3V UNDERVOLTAGE SENSING CIRCUIT.** PAGE # 6-217	1. Monitors +3.3V supplies. (V_{TRIP} = 2.7V typ.) 2. Outputs fully defined at $V_{IN} \geq$ 1V. 3. Ultra-low supply current. (13µA max.) 4. µP Reset function programmable with 1 external resistor and capacitor. 5. Comparator hysteresis prevents output oscillation. 6. Electrically compatible with Motorola MC34164-3. 7. Pin-to-pin compatible with Motorola MC34064/34164.	DM, LP, PK
SG1543/2543/3543	**POWER SUPPLY SUPERVISORY CIRCUIT.** PAGE # 6-255	1. Over-voltage, under-voltage, and current sensing circuits are all included. 2. Programmable time delays. 3. Internal 1% accurate reference available. 4. Open collector outputs. 5. Remote activation capability. 6. SCR "Crowbar" drive of 300mA. 7. Optional over voltage latch. / Uncommitted comparator.	J, N, DW, L

Selection Guide

POWER SUPPLY CIRCUITS

Supervisory Circuits

DEVICE TYPE	DESCRIPTION	KEY FEATURES	PACKAGES
SG1544/2544/3544	**LOW VOLTAGE SUPERVISORY CIRCUIT.** PAGE # *6-257*	1. Uncommitted comparator inputs for low voltage sensing. 2. Over-voltage, under-voltage, and current sensing circuits. 3. Programmable time delays. 4. Internal 1% accurate reference available. 5. Open collector outputs. 6. Remote activation capability. 7. SCR "Crowbar" drive of 300mA. 8. Optional over-voltage latch.	J, N, DW
SG1548/2548/3548	**QUAD POWER FAULT MONITOR.** PAGE # *6-259*	1. Over-voltage and under-voltage sensing on four power supply circuits. 2. Programmable time delay. 3. Internal 1% accurate reference available. 4. Open collector outputs. 5. Adjustable fault window. 6. On-chip inverting op-amp for negative voltage. 7. Additional input for AC line monitoring.	J, N, DW, L
SG33164/34164	**5V UNDER VOLTAGE SENSING CIRCUIT.** PAGE # *6-309*	1. Low standby current. 2. Temperature compensated bandgap reference. 3. Precision comparator with 50mV of hysteresis. 4. Output current sink capability from 7 to 50mA. 5. Pin-for-pin compatable with MC33164/34164. 6. V_{TRIP}= 4.3V.	DM, LP
SG3546	**3.3V UNDER VOLTAGE SENSING CIRCUIT.** PAGE # *6-317*	1. Low standby current. 2. Low operating current consumption. 3. Temperature compensated bandgap reference. 4. Precision comparator with 50mV of hysteresis. 5. Clamp diode for discharging delay capacitor. 6. Output current sink capability from 7 to 50mA. 7. 1-10V input supply range. 8. V_{TRIP}= 2.95V.	DM, LP

LINFINITY MICROELECTRONICS

MOSFET Drivers

DEVICE TYPE	DESCRIPTION	KEY FEATURES	CHARACTERISTICS	PACKAGES
SG1626/2626/3626	**DUAL HIGH-SPEED DRIVER — Inverted** PAGE # 6-263	1. Dual totem pole outputs. 2. High-speed Schottky logic. 3. Frequencies beyond 1MHz. 4. TTL input compatiblity. 5. Rise and fall times less than 25ns. 6. Propagation delays less that 20ns. 7. Efficient operation at high frequency.	$I_{O(PK)}$ 3A; $I_{O(CONT)}$ 0.2A; $V_{C(MAX)}$ 22V; $V_{CC(MAX)}$ 22V	Y, M, J, DW, T, R
SG1644/2644/3644	**DUAL HIGH-SPEED DRIVER — Non-Inverted** PAGE # 6-265	1. Dual totem pole outputs. 2. High-speed Schottky logic. 3. Frequencies beyond 1MHz. 4. TTL input compatiblity. 5. Rise and fall times less than 25ns. 6. Propagation delays less that 20ns. 7. Efficient operation at high frequency.	$I_{O(PK)}$ 3A; $I_{O(CONT)}$ 0.2A; $V_{C(MAX)}$ 22V; $V_{CC(MAX)}$ 22V	Y, M, J, DW, T, R

Support Functions

DEVICE TYPE	DESCRIPTION	KEY FEATURES	PACKAGES
SG1540/2540/3540	**OFF-LINE START UP CONTROLLER.** PAGE # 6-253	1. Eliminates bulky 50/60Hz transformer. 2. Minimizes high-voltage bleeder current. 3. Usable with primary or secondary PWM control. 4. Programmable start up voltage. 5. Programmable over-voltage latch.	Y, M, DW
SG1549/2549/3549	**CURRENT SENSE LATCH.** PAGE # 6-261	1. Current sense latching circuitry. 2. Separate terminals for high and low common-mode sensing. 3. Automatic reset from PWM lock. 4. Complementary outputs available. 5. Low propagation delays. (180ns)	Y, M

LINFINITY MICROELECTRONICS

Selection Guide

POWER SUPPLY CIRCUITS

Switching Regulator Output Stages

PERFORMANCE CHARACTERISTICS

Device Type	Page #	Peak Output Current	Polarity	Input/Output Voltage	Rise Time (ns) Voltage	Rise Time (ns) Current	Fall Time (ns) Voltage	Fall Time (ns) Current	On-State Voltage Transistor	On-State Voltage Diode	Packages
SM645/646/647	6-355	20A	Positive	60V (SM645) 80V (SM646) 100V (SM647)	60	150	175	300	1.5V @ 7A	1.25V @ 7A	K
SM625/626/627	6-353	15A	Positive	60V (SM625) 80V (SM626) 100V (SM627)	60	150	175	300	1.5V @ 7A	1.25V @ 7A	R
SM600/601/602	6-351	5A	Positive	60V (SM600) 80V (SM601) 100V (SM602)	60	150	175	300	1.5V @ 2A	1.0V @ 2A	
SM610/611/612	6-351	5A	Negative	60V (SM600) 80V (SM601) 100V (SM602)	60	150	175	300	1.5V @ 2A	1.0V @ 2A	

Modular Products

DEVICE TYPE: LXM1590/1591

DESCRIPTION: CUSTOMIZABLE CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.

PAGE # 6-159

KEY FEATURES

1. 35% more light output at 2.5 Watts.
2. Closed loop, fully regulating design.
3. 4.5V to 30V input voltage ranges.
4. Versatile brightness control input.
5. 3 microamp sleep current.
6. Output short-circuit protection and automatic over-voltage limiting.
7. Single-sided PCB is self-insulating.
8. 8mm maximum height, narrow footprints.

DEVICE TYPE: LXM1592/1593

DESCRIPTION: FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.

PAGE # 6-169

KEY FEATURES

1. Fully floating output.
2. 35% more light output at 2.5 Watts.
3. Greater efficiency than grounded output designs.
4. 4.5V to 30V input voltage ranges.
5. Versatile brightness control input.
6. 3 microamp sleep current.
7. Output short-circuit protection and automatic over-voltage limiting.
8. 8mm maximum height, narrow footprints.

LINFINITY MICROELECTRONICS

Modular Products

Device Type	Description	Key Features
LXM1596-01	**WIDE INPUT CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.** PAGE # 6-185	**1.** 15 to 30% more light output. **2.** Closed loop, fully regulating design. **3.** 7V to 30V input voltage range. **4.** Versatile brightness control input. **5.** 3 microamp sleep current. **6.** Output short-circuit protection and automatic over-voltage limiting. **7.** Single-sided PCB is self-insulating. **8.** 8mm maximum height, narrow footprints.
LXM1597-01	**5V CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.** PAGE # 6-191	**1.** 15 to 30% more light output. **2.** Closed loop, fully regulating design. **3.** 4.5V to 7V input voltage range. **4.** Versatile brightness control input. **5.** 3 microamp sleep current. **6.** Output short-circuit protection and automatic over-voltage limiting. **7.** Single-sided PCB is self-insulating. **8.** 8mm maximum height, narrow footprints.
LXM1598-01	**12V CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.** PAGE # 6-197	**1.** 15 to 30% more light output. **2.** Closed loop, fully regulating design. **3.** 10V to 14V input voltage ranges. **4.** Versatile brightness control input. **5.** 3 microamp sleep current. **6.** Output short-circuit protection and automatic over-voltage limiting. **7.** Single-sided PCB is self-insulating. **8.** 8mm maximum height, narrow footprints.
LXM1600-05/-12 LXM1600A-05/-12	**5V/12V PENTIUM® PRO (VRM) VOLTAGE REGULATOR MODULE.** PAGE # 6-203	**1.** Maximum output current 12A (typ.). **2.** Total output tolerance of less than ±5%. **3.** Adjustable output voltage using a four bit word. **4.** Over-voltage detection crowbars the output voltage in the event of pass transistor failure - 100% processor protetion. **5.** High efficiency — 85% (typ.). **6.** Power Good signal indicates low output voltage. **7.** Short-circuit protection. **8.** Output Enable/Shutdown.

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX1552/3/4/5

ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

DESCRIPTION

The LX155X family of ultra-low start-up current (250µA max.), current mode control IC's offer new levels of energy efficiency for offline converter applications. They are ideally optimized for personal computer and CRT power supplies although they can be used in any number of off-line applications where energy efficiency is critical. Coupled with the fact that the LX155X series requires a minimal set of external components, the series offers an excellent value for cost conscious consumer applications.

Optimizing energy efficiency, the LX155X series demonstrates a significant power reduction as compared with other similar off-line controllers. Table 1 compares the SG384X, UC384XA and the LX155X start-up resistor power dissipation. The LX155X offers an overall 4X reduction in power dissipation. Additionally, the precise oscillator discharge current gives the power supply designer considerable flexibility in optimizing system duty cycle consistency.

The current mode architecture demonstrates improved load regulation, pulse by pulse current limiting and inherent protection of the power supply output switch. The LX155X includes a bandgap reference trimmed to 1%, an error amplifier, a current sense comparator internally clamped to 1V, a high current totem pole output stage for fast switching of power mosfet's, and an externally programmable oscillator to set operating frequency and maximum duty cycle. The undervoltage lock-out circuitry is designed to operate with as little as 250µA of supply current permitting very efficient bootstrap designs.

KEY FEATURES

- **ULTRA-LOW START-UP CURRENT** (150µA typ.)
- **TRIMMED OSCILLATOR DISCHARGE CURRENT** (±2% typ.)
- **INITIAL OSCILLATOR FREQUENCY BETTER THAN ±4%**
- **OUTPUT PULLDOWN DURING UVLO**
- **PRECISION 2.5V REFERENCE** (±2% max.)
- CURRENT SENSE DELAY TO OUTPUT (150ns typ.)
- AUTOMATIC FEED FORWARD COMPENSATION
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH HYSTERESIS
- DOUBLE PULSE SUPPRESSION
- HIGH CURRENT TOTEM POLE OUTPUT (±1Amp peak)
- 500kHz OPERATION

APPLICATIONS

- ECONOMY OFF-LINE FLYBACK OR FORWARD CONVERTERS
- DC-DC BUCK OR BOOST CONVERTERS
- LOW COST DC MOTOR CONTROL

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF LX155X USING ITS MICROPOWER START-UP FEATURE

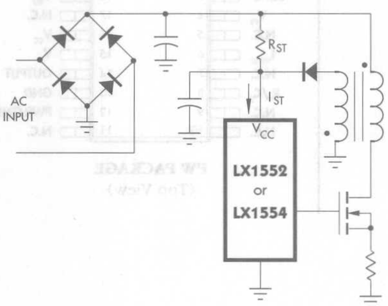


TABLE 1

Design Using	SG384x	UC384xA	LX155x
Max. Start-up Current Specification (I_{ST})	1000µA	500µA	250µA
Typical Start-Up Resistor Value (R_{ST})	62KΩ	124KΩ	248KΩ
Max. Start-Up Resistor Power Dissipation (P_R)	2.26W	1.13W	0.56W

Note: Calculation is done for universal AC input specification of $V_{ACMIN} = 90V_{RMS}$ to $V_{ACMAX} = 265V_{RMS}$ using the following equation: *(Resistor current is selected to be $2 * I_{ST}$ at V_{ACMIN}.)*

$$R_{ST} = \frac{V_{AC\,MIN}}{\sqrt{2} * I_{ST}}, \quad P_R = \frac{2V_{AC\,MAX}^2}{R_{ST}}$$

AVAILABLE OPTIONS PER PART

Part #	Start-Up Voltage	Hysteresis	Max. Duty Cycle
LX1552	16V	6V	<100%
LX1553	8.4V	0.8V	<100%
LX1554	16V	6V	<50%
LX1555	8.4V	0.8V	<50%

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	PW TSSOP 20-pin
0 to 70	LX155xCM	LX155xCDM	LX155xCD	—	LX155xCPW
-40 to 85	LX155xIM	LX155xIDM	LX155xID	—	—
-55 to 125	—	—	—	LX155xMY	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1552CDMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

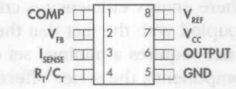
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (Low Impedance Source)	30V
Supply Voltage (I_{CC} < 30mA)	Self Limiting
Output Current	±1A
Output Energy (Capacitive Load)	5µJ
Analog Inputs (Pins 2, 3)	-0.3V to +6.3V
Error Amp Output Sink Current	10mA
Power Dissipation at T_A = 25°C (DIL-8)	1W
Operating Junction Temperature	
Ceramic (Y Package)	150°C
Plastic (M, DM, D, PW Packages)	150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 10 Seconds)	300°C

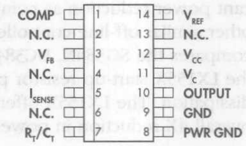
Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

PACKAGE PIN OUTS

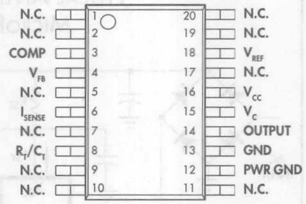
M & Y PACKAGE
(Top View)



DM PACKAGE
(Top View)



D PACKAGE
(Top View)



PW PACKAGE
(Top View)

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

D PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Y PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W

PW PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	144°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX155xC with 0°C ≤ T_A ≤ 70°C, LX155xI with -40°C ≤ T_A ≤ 85°C, LX155xM with -55°C ≤ T_A ≤ 125°C; V_{CC}=15V (Note 5); R_T=10K; C_T=3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX155xI/155xM Min.	LX155xI/155xM Typ.	LX155xI/155xM Max.	LX155xC Min.	LX155xC Typ.	LX155xC Max.	Units
Reference Section									
Output Voltage	V_{REF}	T_A = 25°C, I_L = 1mA	4.95	5.00	5.05	4.95	5.00	5.05	V
Line Regulation		12 ≤ V_{IN} ≤ 25V		6	20		6	20	mV
Load Regulation		1 ≤ I_O ≤ 20mA		6	25		6	25	mV
Temperature Stability (Note 2 & 7)				0.2	0.4		0.2	0.4	mV/°C
Total Output Variation		Over Line, Load, and Temperature	4.9		5.1	4.9		5.1	V
Output Noise Voltage (Note 2)	V_N	10Hz ≤ f ≤ 10kHz, T_A = 25°C		50			50		µV
Long Term Stability (Note 2)		T_A = 125°C, t = 1000hrs		5	25		5	25	mV
Output Short Circuit	I_{SC}		-30	-100	-180	-30	-100	-180	mA
Oscillator Section									
Initial Accuracy (Note 6)		T_A = 25°C	48.5	50.5	52.5	48.5	50.5	52.5	kHz
		T_A = 25°C, R_T = 698Ω, C_T = 22nF, LX1552/3 only	56	58	60	56	58	60	kHz
Voltage Stability		12 ≤ V_{CC} ≤ 25V		0.2	1		0.2	1	%
Temperature Stability (Note 2)		T_{MIN} ≤ T_A ≤ T_{MAX}		5			5		%
Amplitude (Note 2)		$V_{PIN\,4}$ peak to peak		1.7			1.7		V
Discharge Current	I_D	T_A = 25°C, $V_{PIN\,4}$ = 2V	8.0	8.3	8.6	8.0	8.3	8.6	mA
		$V_{PIN\,4}$ = 2V, T_{MIN} ≤ T_A ≤ T_{MAX}	7.6		8.8	7.8		8.8	mA
Error Amp Section									
Input Voltage		$V_{PIN\,1}$ = 2.5V	2.45	2.50	2.55	2.45	2.50	2.55	V
Input Bias Current	I_B			-0.1	-1		-0.1	-0.5	µA
Open Loop Gain	A_{VOL}	2 ≤ V_O ≤ 4V	65	90		65	90		dB
Unity Gain Bandwidth (Note 2)	UGBW	T_A = 25°C		0.6			0.6		MHz
Power Supply Rejection Ratio (Note 3)	PSRR	12 ≤ V_{CC} ≤ 25V	60	70		60	70		dB
Output Sink Current	I_{OL}	$V_{PIN\,2}$ = 2.7V, $V_{PIN\,1}$ = 1.1V	2	4		2	4		mA
Output Source Current	I_{OH}	$V_{PIN\,2}$ = 2.3V, $V_{PIN\,1}$ = 5V	-0.5	-0.8		-0.5	-0.8		mA
Output Voltage High Level	V_{OH}	$V_{PIN\,2}$ = 2.3V, R_L = 15K to ground	5	6.5		5	6.5		V
Output Voltage Low Level	V_{OL}	$V_{PIN\,2}$ = 2.7V, R_L = 15K to V_{REF}		0.7	1.1		0.7	1.1	V
Current Sense Section									
Gain (Note 3 & 4)	A_{VOL}		2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 3)		$V_{PIN\,1}$ = 5V	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 3)	PSRR	12 ≤ V_{CC} ≤ 25V		70			70		dB
Input Bias Current	I_B			-2	-10		-2	-5	µA
Delay to Output (Note 2)	T_{PD}	$V_{PIN\,3}$ = 0 to 2V		150	300		150	300	ns
Output Section									
Output Voltage Low Level	V_{OL}	I_{SINK} = 20mA		0.1	0.4		0.1	0.4	V
		I_{SINK} = 200mA		1.5	2.2		1.5	2.2	V
Output Voltage High Level	V_{OH}	I_{SOURCE} = 20mA	13	13.5		13	13.5		V
		I_{SOURCE} = 200mA	12	13.5		12	13.5		V
Rise Time (Note 2)	T_R	T_A = 25°C, C_L = 1nF		50	100		50	100	ns
Fall Time (Note 2)	T_F	T_A = 25°C, C_L = 1nF		50	100		50	100	ns
UVLO Saturation	V_{SAT}	V_{CC} = 5V, I_{SINK} = 10mA		0.7	1.2		0.7	1.2	V

(Electrical Characteristics continue next page.)

ELECTRICAL CHARACTERISTICS (Con't.)

Parameter	Symbol	Test Conditions	LX155xI/155xM Min.	LX155xI/155xM Typ.	LX155xI/155xM Max.	LX155xC Min.	LX155xC Typ.	LX155xC Max.	Units
Under-Voltage Lockout Section									
Start Threshold	V_{ST}	1552/1554	15	16	17	15	16	17	V
		1553/1555	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operation Voltage After Turn-On		1552/1554	9	10	11	9	10	11	V
		1553/1555	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section									
Maximum Duty Cycle		1552/1553	94	96		94	96		%
		1552/1553, $R_T = 698\Omega$, $C_T = 22nF$		50			50		%
		1554/1555	47	48		47	48		%
Minimum Duty Cycle					0			0	%
Power Consumption Section									
Start-Up Current	I_{ST}			150	250		150	250	µA
Operating Supply Current	I_{CC}			11	17		11	17	mA
V_{CC} Zener Voltage	V_Z	$I_{CC} = 25mA$	30	35		30	35		V

Notes: 2. These parameters, although guaranteed, are not 100% tested in production.

3. Parameter measured at trip point of latch with $V_{FB} = 0$.

4. Gain defined as: $A = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$; $0 \le V_{ISENSE} \le 0.8V$.

5. Adjust V_{CC} above the start threshold before setting at 15V.

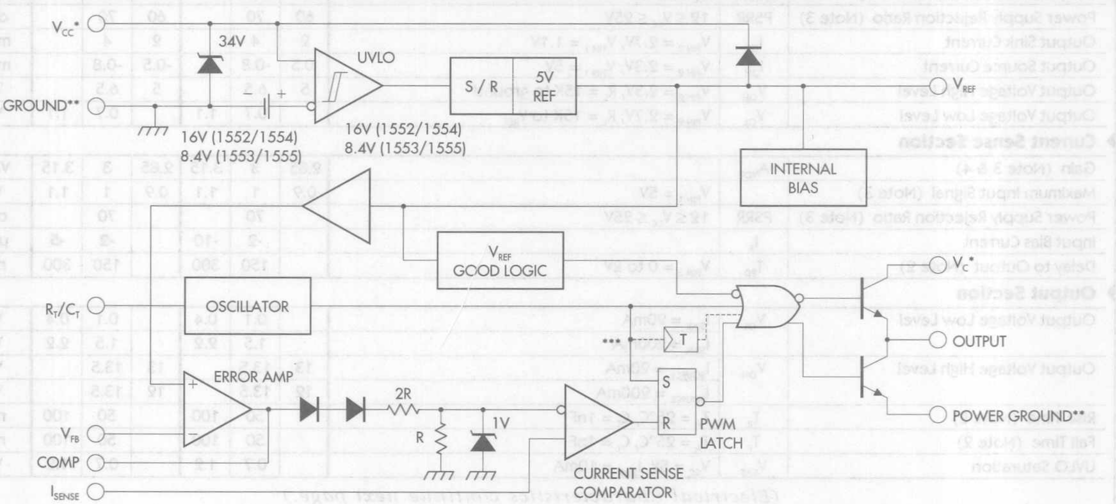
6. Output frequency equals oscillator frequency for the LX1552 and LX1553. Output frequency is one half oscillator frequency for the LX1554 and LX1555.

7. Temperature stability, sometimes referred to as average temperature coefficient, is described by the equation:

$$\text{Temp Stability} = \frac{V_{REF}\ (\text{max.}) - V_{REF}\ (\text{min.})}{T_A\ (\text{max.}) - T_A\ (\text{min.})}$$

V_{REF} (max.) & V_{REF} (min.) are the maximum & minimum reference voltage measured over the appropriate temperature range. Note that the extremes in voltage do not necessarily occur at the extremes in temperature.

BLOCK DIAGRAM



* - V_{CC} and V_C are internally connected for 8 pin packages.
** - POWER GROUND and GROUND are internally connected for 8 pin packages.
*** - Toggle flip flop used only in 1554 and 1555.

LINFINITY MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Theory of Operation Section

Typical Applications Section

CHARACTERISTIC CURVES

FIGURE 1. — OSCILLATOR FREQUENCY vs. TIMING RESISTOR

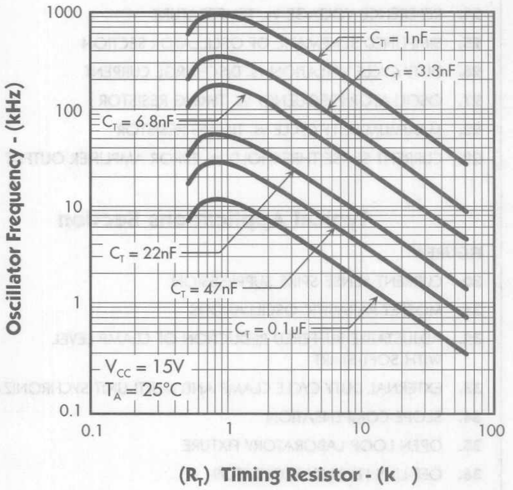


FIGURE 2. — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR

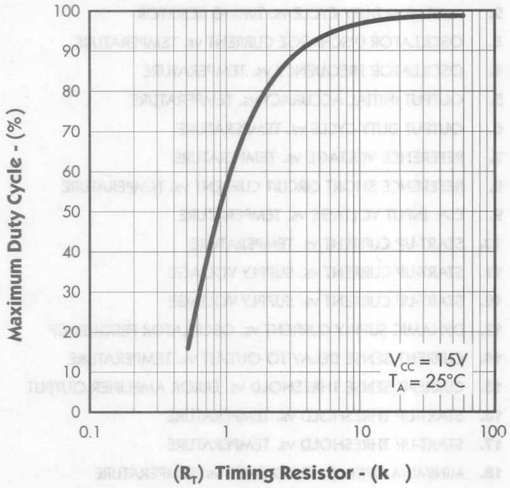


FIGURE 3. — OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE

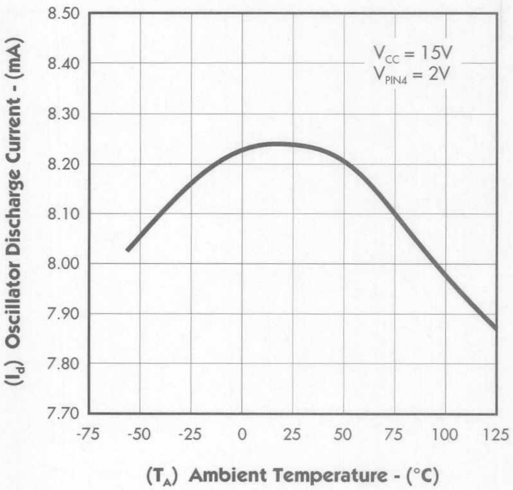
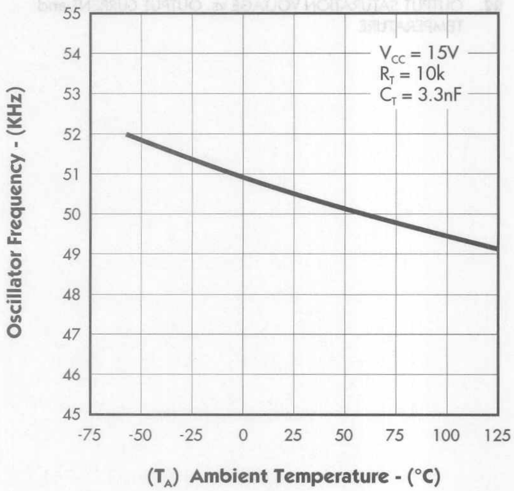


FIGURE 4. — OSCILLATOR FREQUENCY vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — OUTPUT INITIAL ACCURACY vs. TEMPERATURE

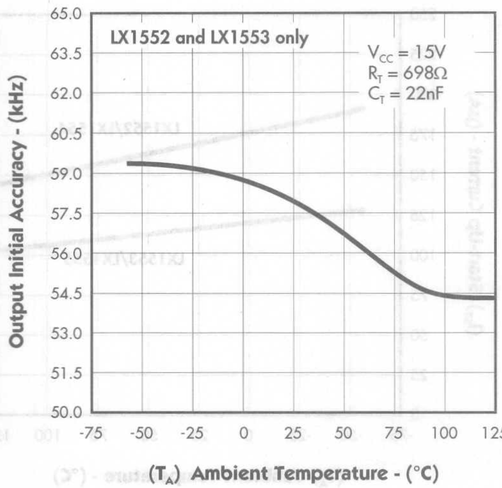


FIGURE 6. — OUTPUT DUTY CYCLE vs. TEMPERATURE

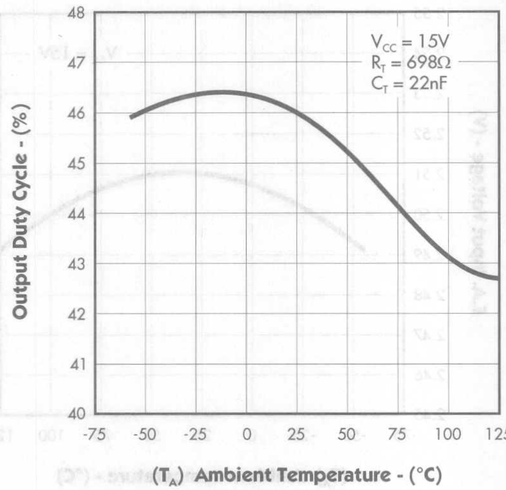


FIGURE 7. — REFERENCE VOLTAGE vs. TEMPERATURE

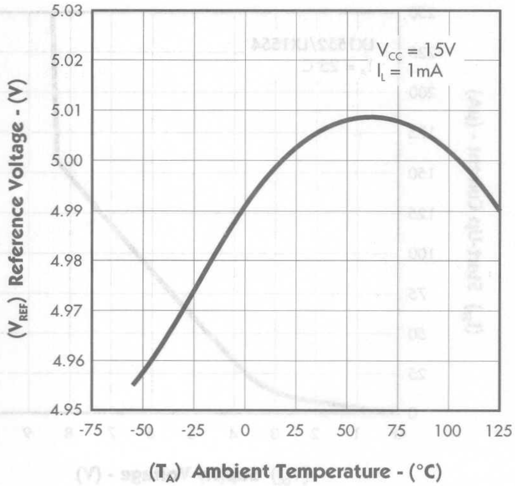
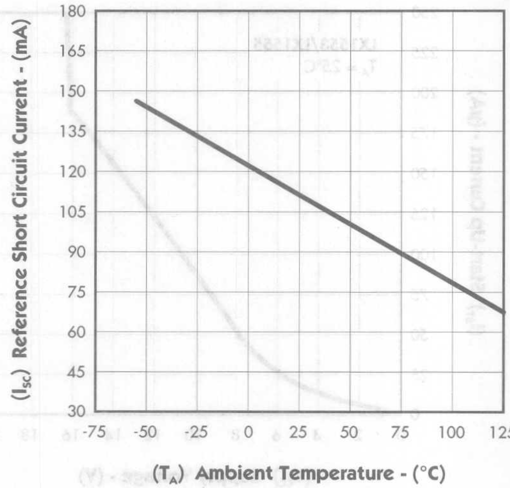


FIGURE 8. — REFERENCE SHORT CIRCUIT CURRENT vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 9. — E.A. INPUT VOLTAGE vs. TEMPERATURE

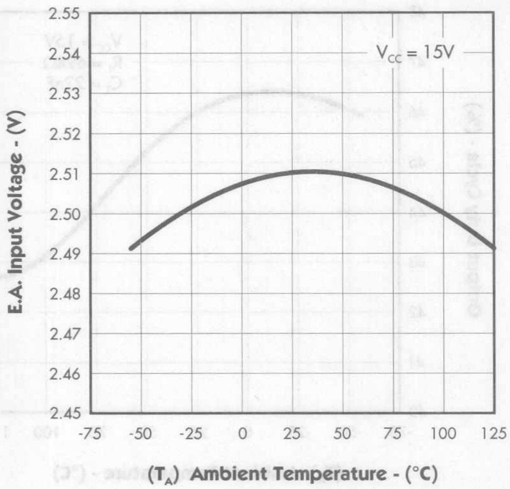


FIGURE 10. — START-UP CURRENT vs. TEMPERATURE

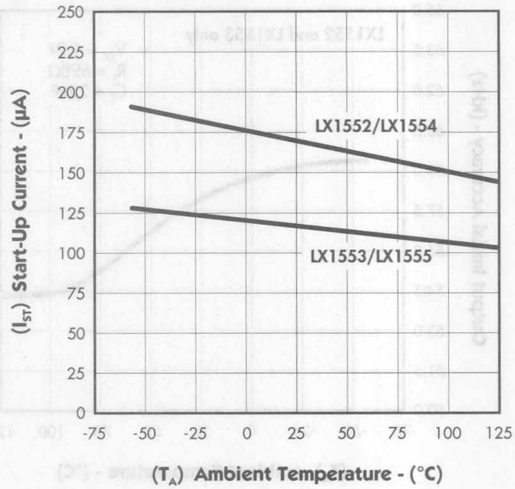


FIGURE 11. — START-UP CURRENT vs. SUPPLY VOLTAGE

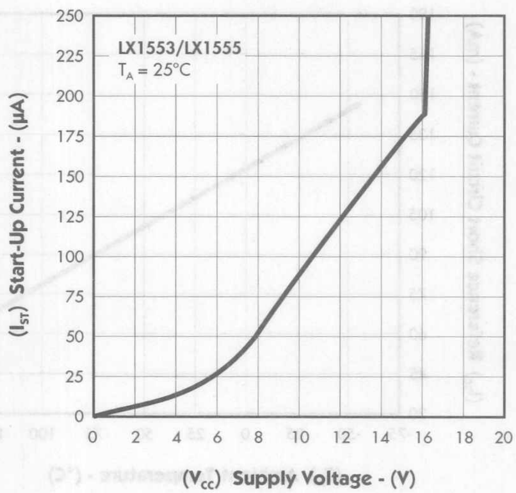
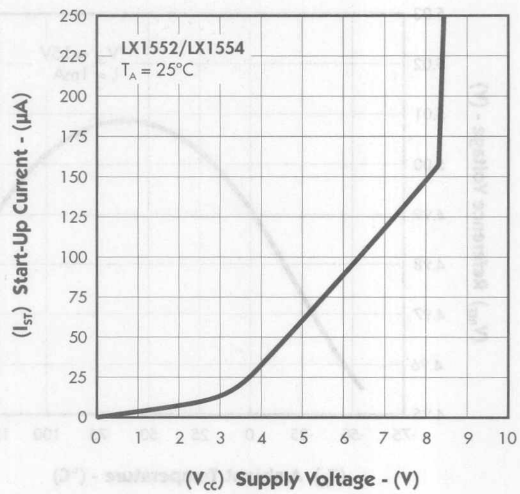


FIGURE 12. — START-UP CURRENT vs. SUPPLY VOLTAGE



CHARACTERISTIC CURVES

FIGURE 13. — DYNAMIC SUPPLY CURRENT vs. OSCILLATOR FREQUENCY

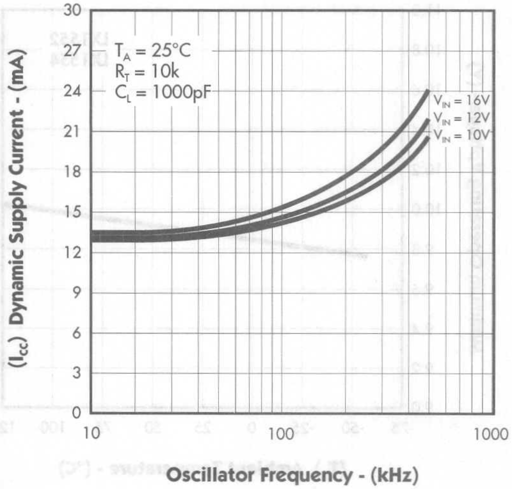


FIGURE 14. — CURRENT SENSE DELAY TO OUTPUT vs. TEMPERATURE

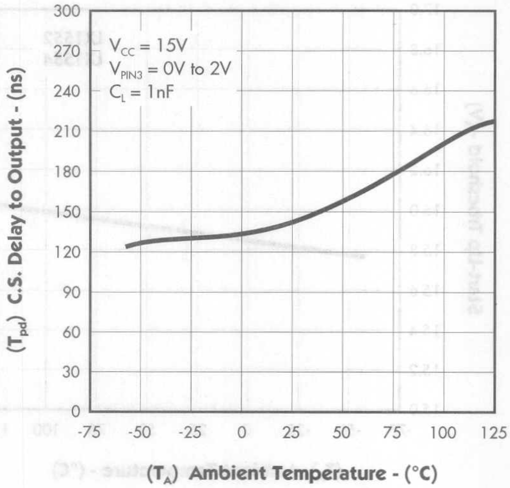


FIGURE 15. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT

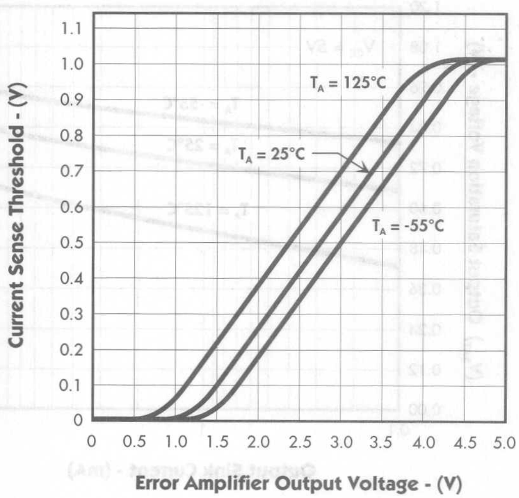
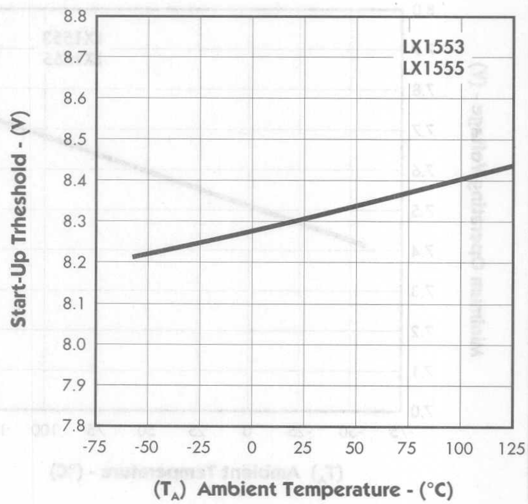


FIGURE 16. — START-UP THRESHOLD vs. TEMPERATURE



LINFINITY MICROELECTRONICS

ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

CHARACTERISTIC CURVES

FIGURE 17. — START-UP THRESHOLD vs. TEMPERATURE

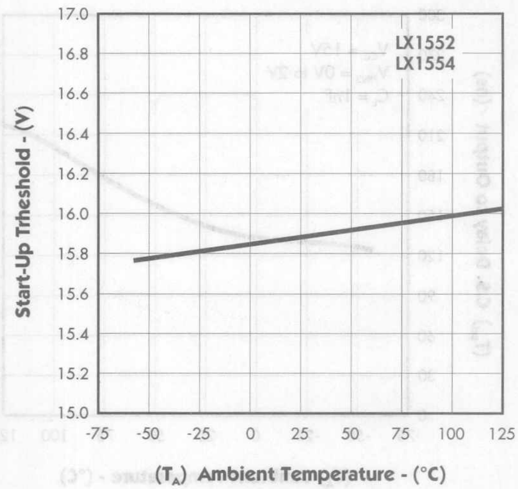


FIGURE 18. — MINIMUM OPERATING VOLTAGE vs. TEMPERATURE

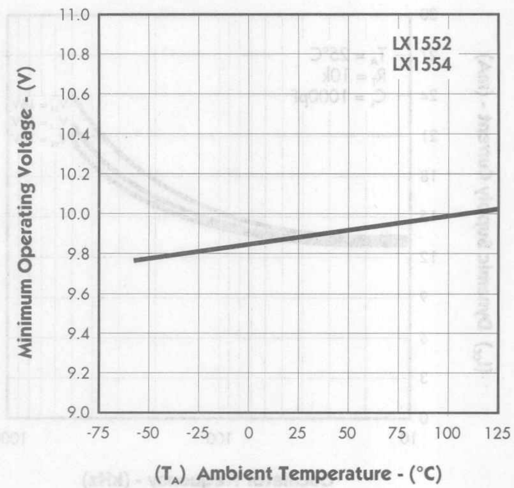


FIGURE 19. — MINIMUM OPERATING VOLTAGE vs. TEMPERATURE

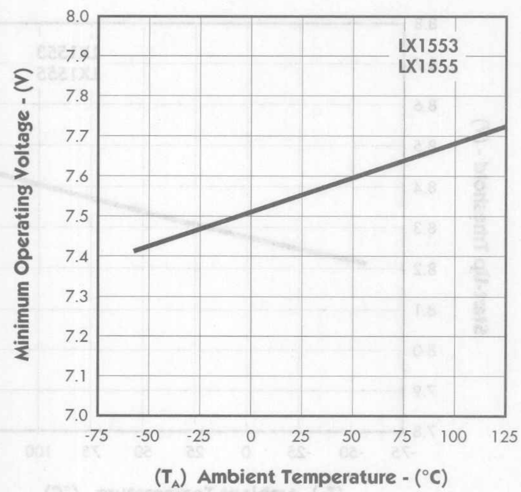
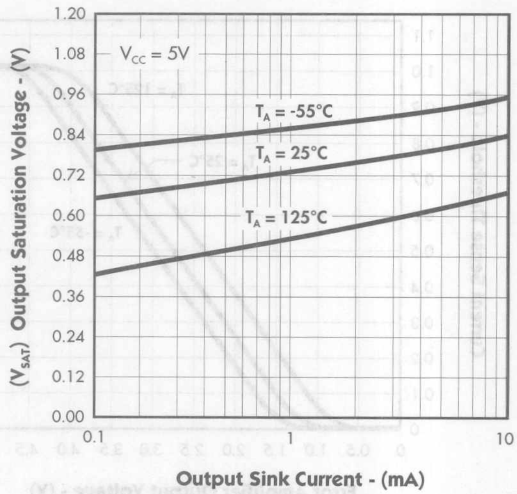


FIGURE 20. — LOW LEVEL OUTPUT SATURATION VOLTAGE DURING UNDER-VOLTAGE LOCKOUT



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 21. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT and TEMPERATURE

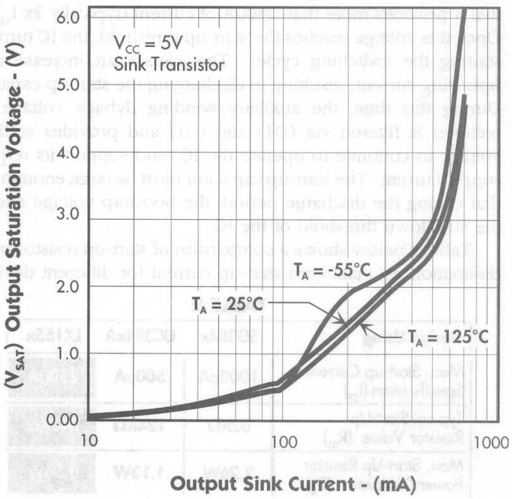
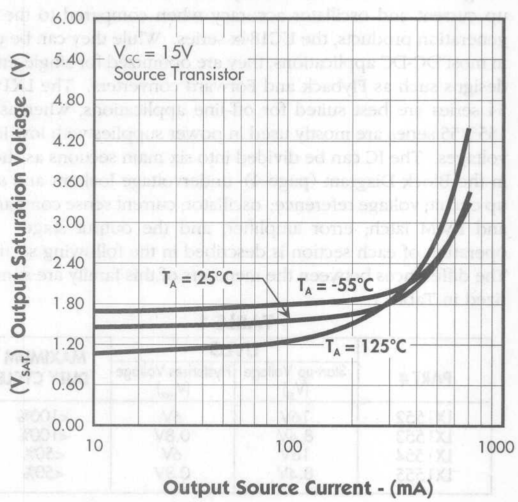


FIGURE 22. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT and TEMPERATURE



LINFINITY MICROELECTRONICS

THEORY OF OPERATION

IC DESCRIPTION

The LX1552/3/4/5 series of current mode PWM controller IC's are designed to offer substantial improvements in the areas of start-up current and oscillator accuracy when compared to the first generation products, the UC184x series. While they can be used in most DC-DC applications, they are optimized for single-ended designs such as Flyback and Forward converters. The LX1552/54 series are best suited for off-line applications, whereas the 1553/55 series are mostly used in power supplies with low input voltages. The IC can be divided into six main sections as shown in the Block Diagram (page 4): undervoltage lockout and start-up circuit; voltage reference; oscillator; current sense comparator and PWM latch; error amplifier; and the output stage. The operation of each section is described in the following sections. The differences between the members of this family are summarized in Table 1.

TABLE 1

PART #	UVLO		MAXIMUM DUTY CYCLE
	Start-up Voltage (V_{ST})	Hysterises Voltage (V_{HYS})	
LX1552	16V	6V	<100%
LX1553	8.4V	0.8V	<100%
LX1554	16V	6V	<50%
LX1555	8.4V	0.8V	<50%

UNDERVOLTAGE LOCKOUT

The LX155x undervoltage lock-out is designed to maintain an ultra low quiescent current of less than 250µA, while guaranteeing the IC is fully functional before the output stage is activated. Comparing this to the SG384x series, a 4x reduction in start-up current is achieved resulting in 75% less power dissipation in the start-up resistor. This is especially important in off-line power supplies which are designed to operate for universal input voltages of 90 to 265V AC.

Figure 23 shows an efficient supply voltage using the ultra low start-up current of the LX1554 in conjunction with a bootstrap winding off of the power transformer. Circuit operation is as follows.

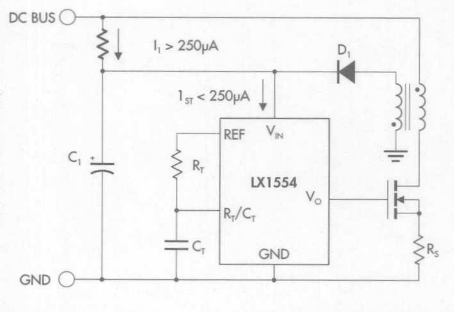


FIGURE 23 — TYPICAL APPLICATION OF START-UP CIRCUITRY

The start-up capacitor (C1) is charged by current through resistor (R1) minus the start-up current. Resistor (R1) is designed such that it provides more than 250µA of current (typically 2x $I_{ST(max)}$). Once this voltage reaches the start-up threshold, the IC turns on, starting the switching cycle. This causes an increase in IC operating current, resulting in discharging the start-up capacitor. During this time, the auxiliary winding flyback voltage gets rectified & filtered via (D1) and (C1) and provides sufficient voltage to continue to operate the IC and support its required supply current. The start-up capacitor must be large enough such that during the discharge period, the bootstrap voltage exceeds the shutdown threshold of the IC.

Table 2 below shows a comparison of start-up resistor power dissipation vs. maximum start-up current for different devices.

TABLE 2

Design Using	SG384x	UC384xA	LX155x
Max. Start-up Current Specification (I_{ST})	1000µA	500µA	250µA
Typical Start-Up Resistor Value (R_{ST})	62KΩ	124KΩ	248KΩ
Max. Start-Up Resistor Power Dissipation (P_R)	2.26W	1.13W	0.56W

(Resistor R1 is designed such that it provides 2X maximum start-up current under low line conditions. Maximum power dissipation is calculated under maximum line conditions. Example assumes 90 to 265VAC universal input application.)

LINFINITY MICROELECTRONICS

THEORY OF OPERATION

VOLTAGE REFERENCE

The voltage reference is a low drift bandgap design which provides +5.0V to supply charging current to the oscillator timing capacitor, as well as supporting internal circuitries. Initial accuracy for all devices are specified at ±1% max., which is a 2x improvement for the commercial product when compared to the SG384x series. The reference is capable of providing in excess of 20mA for powering any external control circuitries and has built-in short circuit protection.

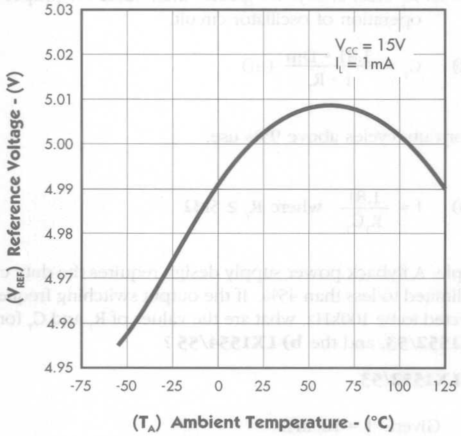


FIGURE 24 — REFERENCE VOLTAGE vs. TEMPERATURE

OSCILLATOR

The oscillator circuit is designed such that discharge current and valley voltage are trimmed independently. This results in more accurate initial oscillator frequency and maximum output duty cycle, especially important in LX1552/53 applications. The oscillator is programmed by the values selected for the timing components (R_T) and (C_T). A simplified schematic of the oscillator is shown in Figure 25. The operation is as follows; Capacitor (C_T) is charged from the 5V reference thru resistor (R_T) to a peak voltage of 2.7V nominally. Once the voltage reaches this threshold, comparator (A1) changes state, causing (S1) to switch to position (2) and (S2) to (V_V) position. This will allow the capacitor to discharge with a current equal to the difference between a constant discharge current (I_D) and current through charging resistor (I_R), until the voltage drops down to 1V nominally and the comparator changes state again, repeating the cycle. Oscillator charge time results in the output to be in a high state (on time) and discharge time sets it to a low state (off time). Since the oscillator period is the sum of the charge and discharge time, any variations in either of them will ultimately affect stability of the output frequency and the maximum duty cycle. In fact, this

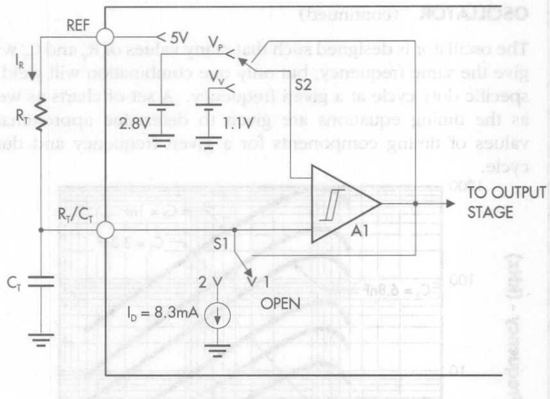


FIGURE 25 — SIMPLIFIED SCHEMATIC OF OSCILLATOR SECTION

variation is more pronounced when maximum duty cycle has to be limited to 50% or less. This is due to the fact that for longer output off time, capacitor discharge current (I_D - I_R) must be decreased by increasing I_R. Consequently, this increases the sensitivity of the frequency and duty cycle to any small variations of the internal current source (I_D), making this parameter more critical under those conditions. Because this is a desired feature in many applications, this parameter is trimmed to a nominal current value of 8.3±0.3mA at room temperature, and guaranteed to a maximum range of 7.8 to 8.8mA over the specified ambient temperature range. Figure 26 shows variation of oscillator duty cycle versus discharge current for LX155x and SG384x series devices.

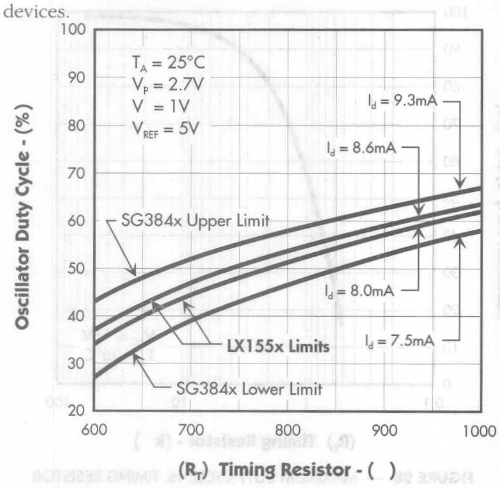


FIGURE 26 — DUTY CYCLE VARIATION vs. DISCHARGE CURRENT

THEORY OF OPERATION

OSCILLATOR (continued)

The oscillator is designed such that many values of R_T and C_T will give the same frequency, but only one combination will yield a specific duty cycle at a given frequency. A set of charts as well as the timing equations are given to determine approximate values of timing components for a given frequency and duty cycle.

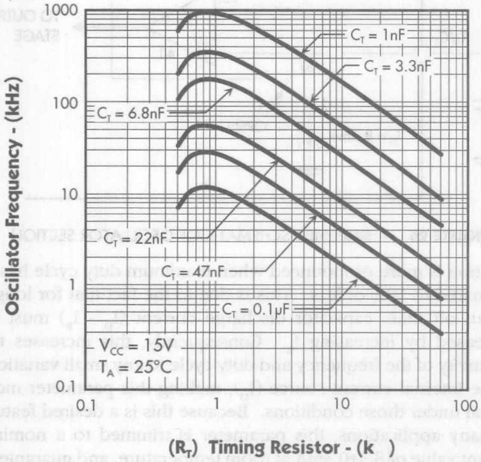


FIGURE 27 OSCILLATOR FREQUENCY vs. TIMING RESISTOR

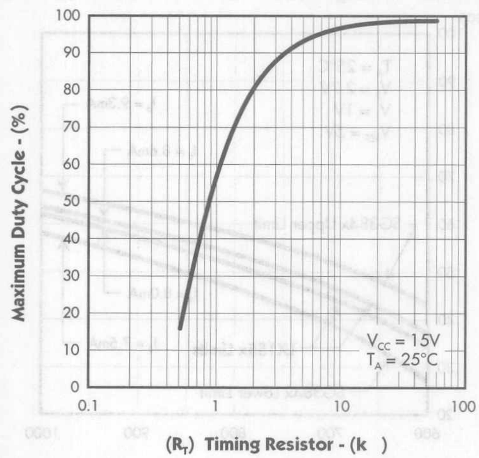


FIGURE 28 — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR

Given: frequency ≅ f; maximum duty-cycle ≅ Dm
Calculate:

1) $$R_T = 277 \left[\frac{(1.74)^{\frac{1}{Dm}} - 1}{(1.74)^{\frac{1-Dm}{Dm}} - 1} \right] (\Omega),\ 0.3 \le Dm \le 0.95$$

Note: R_T must always be greater than 520Ω for proper operation of oscillator circuit.

2) $$C_T = \frac{1.81 * Dm}{f * R_T} \ (\mu f)$$

for duty cycles above 95% use:

3) $$f \approx \frac{1.81}{R_T C_T} \quad \text{where } R_T \ge 5k\Omega$$

Example: A flyback power supply design requires the duty cycle to be limited to less than 45%. If the output switching frequency is selected to be 100kHz, what are the values of R_T and C_T for the **a) LX1552/53**, and the **b) LX1554/55** ?

a) LX1552/53

Given: f = 100kHz
Dm = 0.45

$$R_T = 267 \left[\frac{(1.74)^{\frac{1}{.45}} - 1}{(1.74)^{\frac{.55}{.45}} - 1} \right] = 669\Omega$$

$$C_T = \frac{1.81 * 0.45}{100x10^3 * 669} = .012\ \mu f$$

b) LX1554/55

f_{OUT} = ½ f_{OSC} (due to internal flip flop)
f_{OSC} = 200kHz

select C_T = 1000pf
using Figure 27 or Equation 3: R_T = 9.1k

LINFINITY
MICROELECTRONICS

THEORY OF OPERATION

CURRENT SENSE COMPARATOR AND PWM LATCH

Switch current is sensed by an external sense resistor (or a current transformer), monitored by the C.S. pin and compared internally with voltage from error amplifier output. The comparator output resets the PWM latch ensuring that a single pulse appears at the output for any given oscillator cycle. The LX1554/55 series has an additional flip flop stage that limits the output to less than 50% duty cycle range as well as dividing its output frequency to half of the oscillator frequency. The current sense comparator threshold is internally clamped to 1V nominally which would limit peak switch current to:

$$(1)\ I_{SP} = \frac{V_Z}{R_S} \quad \text{where:} \quad I_{SP} \equiv \text{Peak switch current},\ V_Z \equiv \text{internal zener},\ 0.9V \leq V_Z \leq 1.1V$$

Equation 1 is used to calculate the value of sense resistor during the current limit condition where switch current reaches its maximum level. In normal operation of the converter, the relationship between peak switch current and error voltage (voltage at pin 1) is given by:

$$(1)\ I_{SP} = \frac{V_E - 2V_F}{3 * R_S} \quad \text{where:} \quad V_E \equiv \text{Voltage at pin 1},\ V_F \equiv \text{Diode - Forward voltage},\ 0.7V \text{ at } T_A = 25°C$$

The above equation is plotted in Figure 29. Notice that the gain becomes non-linear above current sense voltages greater than ≈ 0.95 volts. It is therefore recommended to operate below this range during normal operation. This would insure that the overall closed loop gain of the system will not be affected by the change in the gain of the current sense stage.

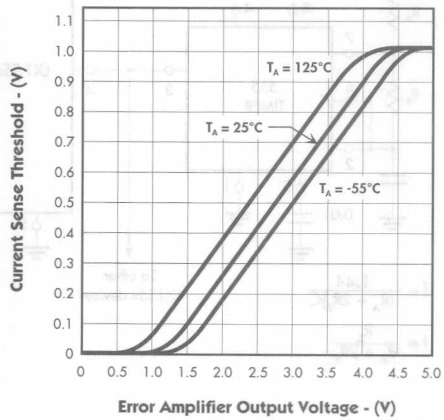


FIGURE 29 — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT

ERROR AMPLIFIER

The error amplifier has a PNP input differential stage with access to the Inverting input and the output pin. The N.I. input is internally biased to 2.5 volts and is not available for any external connections. The maximum input bias current for the LX155XC series is 0.5µA, while LX155XI/155XM devices are rated for 1µA maximum over their specified range of ambient temperature. Low value resistor dividers should be used in order to avoid output voltage errors caused by the input bias current. The error amplifier can source 0.5mA and sink 2mA of current. A minimum feedback resistor (R_F) value of is given by:

$$R_{FMIN} = \frac{3(1.1) + 1.8}{0.5mA} \approx 10K$$

OUTPUT STAGE

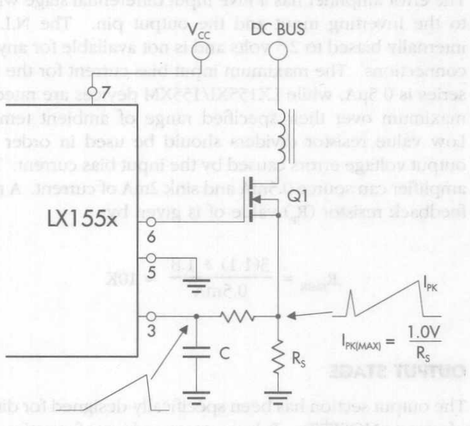
The output section has been specifically designed for direct drive of power MOSFETs. It has a totempole configuration which is capable of high peak current for fast charging and discharging of external MOSFET gate capacitance. This typically results in a rise and fall time of 50ns for a 1000pf capacitive load. Each output transistor (source and sink) is capable of supplying 200mA of continuous current with typical saturation voltages versus temperature as shown in Figures 21 & 22 of the characteristic curve section. All devices are designed to minimize the amount of shoot-thru current which is a result of momentary overlap of output transistors. This allows more efficient usage of the IC at higher frequencies, as well as improving the noise susceptibility of the device. Internal circuitry insures that the outputs are held off during V_{CC} ramp-up. Figure 20, in the characteristic curves section, shows output sink saturation voltage vs. current at 5V.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

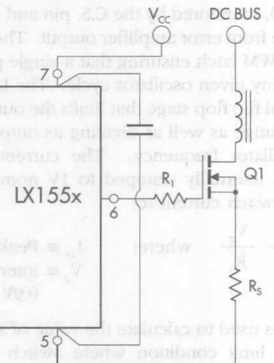
Unless otherwise specified, pin numbers refer to 8-pin package.

FIGURE 30. — CURRENT SENSE SPIKE SUPPRESSION



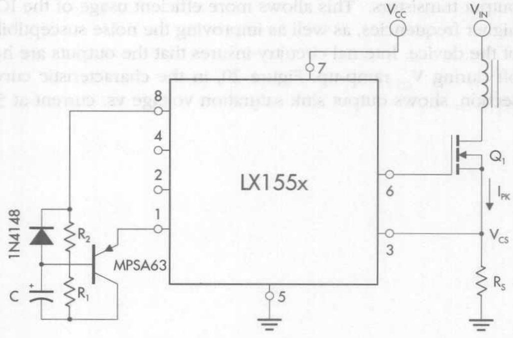
The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

FIGURE 31. — MOSFET PARASITIC OSCILLATIONS



A resistor (R_1) in series with the MOSFET gate reduces overshoot & ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

FIGURE 32. ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFT-START



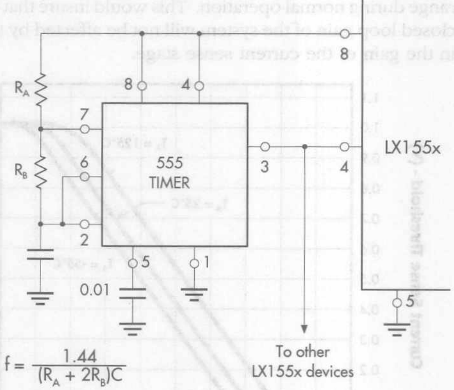
$I_{PK} = \frac{V_{CS}}{R_S}$ Where: $V_{CS} = 1.67\left(\frac{R_1}{R_1+R_2}\right)$ and $V_{C.S.MAX} = 1V$ (Typ.)

$$t_{SOFTSTART} = -\ln\left[1 - \frac{V_{EAO} - 1.3}{5\left(\frac{R_1}{R_1+R_2}\right)}\right]\left(\frac{R_1 R_2}{R_1+R_2}\right) C$$

where; $V_{EAO} \equiv$ voltage at the Error Amp Output under minimum line and maximum load conditions.

Soft start and adjustable peak current can be done with the external circuitry shown above.

FIGURE 33. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION



$$f = \frac{1.44}{(R_A + 2R_B)C}$$

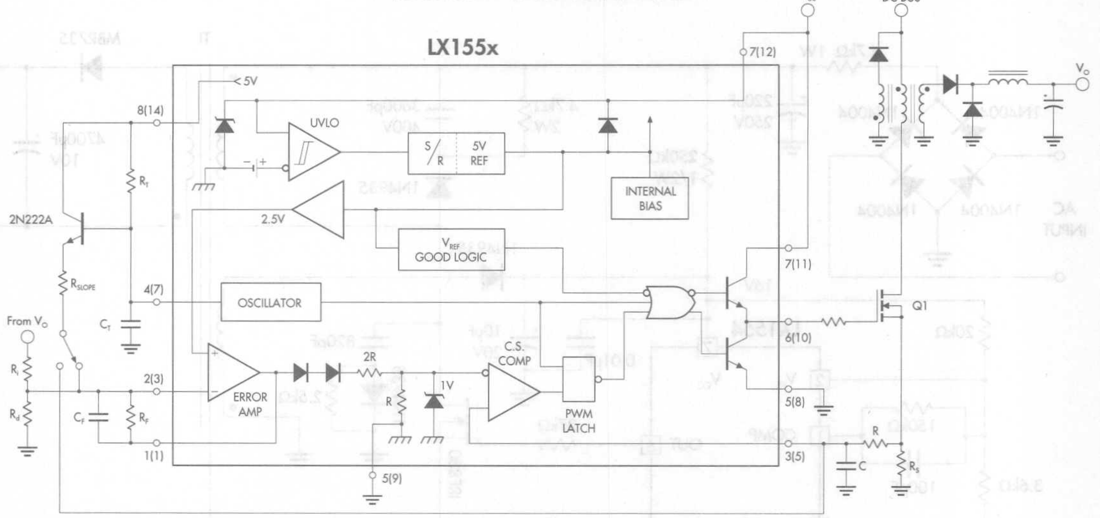
$$f = \frac{R_B}{R_A + 2R_B}$$

Precision duty cycle limiting as well as synchronizing several parts is possible with the above circuitry.

LINFINITY MICROELECTRONICS

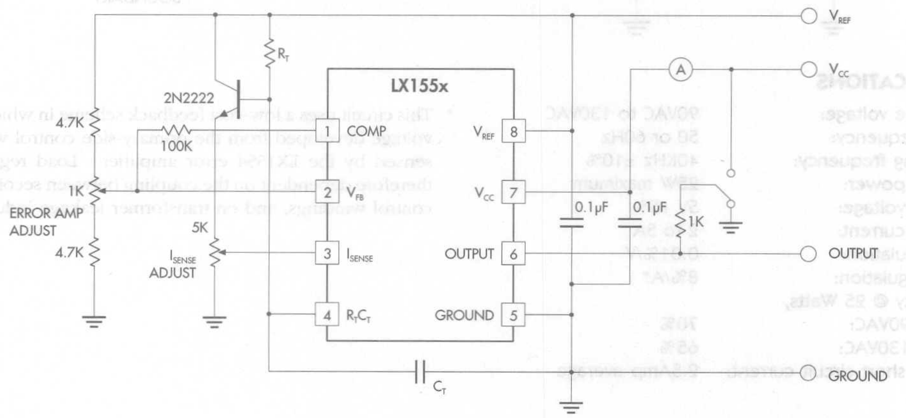
TYPICAL APPLICATION CIRCUITS (continued)

FIGURE 34. — SLOPE COMPENSATION



Due to inherent instability of fixed frequency current mode converters running above 50% duty cycle, slope compensation should be added to either the current sense pin or the error amplifier. Figure 34 shows a typical slope compensation technique. Pin numbers inside parenthesis refer to 14-pin package.

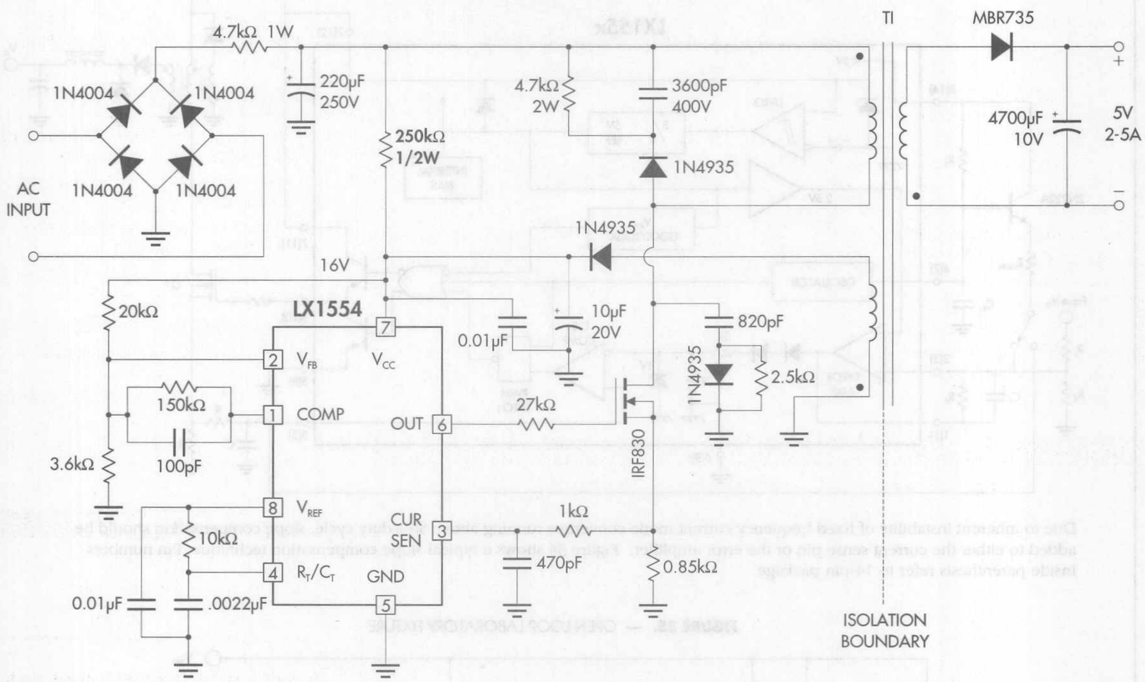
FIGURE 35. — OPEN LOOP LABORATORY FIXTURE



High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.

TYPICAL APPLICATION CIRCUITS (continued)

FIGURE 36. — OFF-LINE FLYBACK REGULATOR



SPECIFICATIONS

Input line voltage:	90VAC to 130VAC
Input frequency:	50 or 60Hz
Switching frequency:	40KHz ±10%
Output power:	25W maximum
Output voltage:	5V +5%
Output current:	2 to 5A
Line regulation:	0.01%/V
Load regulation:	8%/A*
Efficiency @ 25 Watts,	
V_{IN} = 90VAC:	70%
V_{IN} = 130VAC:	65%
Output short-circuit current:	2.5Amp average

* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the LX1554 error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX1562/1563

SECOND-GENERATION POWER FACTOR CONTROLLER

PRODUCTION DATA SHEET

DESCRIPTION

The LX1562 is a second-generation family of power factor correction controllers using a discontinuous mode of operation. They are optimized for electronic ballast applications. Many improvements have been made over the original SG3561A controller introduced by Silicon General Semiconductor in 1992.

New features include the addition of an internal start-up circuit eliminating bulky external components while allowing independent boost converter operation. Addition of internal current sense blanking eliminating the need for an external R/C filter network. Internal clamping of the error amplifier and multiplier outputs improves turn on overshoot characteristics and current limiting. Special circuitry has also been added to prevent no load runaway conditions. And finally, output drive clamps limiting power MOSFET gate drive independent of supply voltage greatly enhance the products practical application.

Although the IC design has been optimized for electronic ballast applications, it can also be used for power factor correction in lower power (typ < 300W) AC-DC converters. One unique feature of the device is encompassed by the addition of internal logic circuitry to detect zero crossing of the inductor current thus maintaining the discontinuous current mode of operation. This feature prevents large current gaps from appearing thereby minimizing distortion and enhancing power factor correction.

KEY FEATURES

- **INTERNAL START-UP CIRCUIT**
- **INTERNAL CURRENT SENSE BLANKING**
- **IMPROVED MICROPOWER START-UP CURRENT** (300µA max.)
- **CLAMPED E.A. OUTPUT FOR LOWER TURN-ON OVERSHOOT**
- **MULTIPLIER CLAMP LIMITS MAXIMUM INPUT CURRENT**
- **INTERNAL OVERVOLTAGE PROTECTION REPLACES BUILT-IN C.S. OFFSET**
- **PWM OUTPUT CLAMP LIMITS MOSFET GATE DRIVE VOLTAGE**
- **INCREASED UVLO HYSTERESIS REDUCES START-UP TIMING** (LX1562 only)
- LOW OPERATING CURRENT CONSUMPTION
- INTERNAL 1.5% REFERENCE
- TOTEM POLE OUTPUT STAGE
- AUTOMATIC CURRENT LIMITING OF BOOST STAGE
- DISCONTINUOUS MODE OF OPERATION WITH NO CURRENT GAPS
- NO SLOPE COMPENSATION REQUIRED

APPLICATIONS

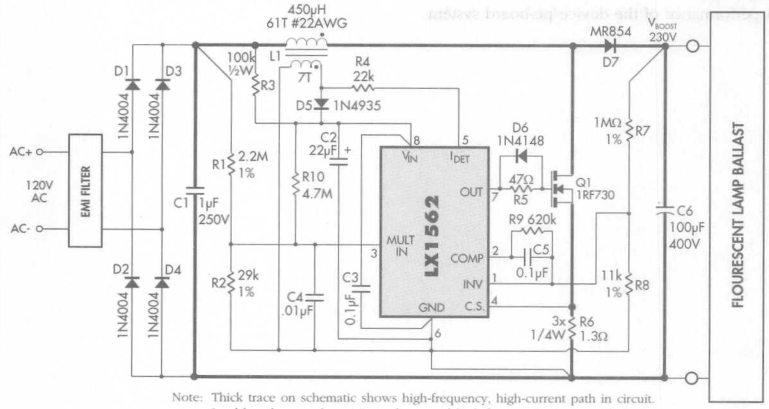
- ELECTRONIC BALLAST
- SWITCHING POWER SUPPLIES

AVAILABLE OPTIONS PER PART #

Part #	Start-Up Voltage	Hysteresis Voltage
LX1562	13.1V	5.2V
LX1563	9.8V	2.1V

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
0 to 100	LX1562IM	LX1562IDM
0 to 100	LX1563IM	LX1563IDM

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1562IDMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX1562/1563

SECOND-GENERATION POWER FACTOR CONTROLLER

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V_{IN}) .... -0.3V to 28V
Peak Driver Output Current (Note 3) .... ±500mA
Driver Output Clamping Diodes
$V_O > V_{CC}$ or $V_O < -0.3V$ .... ±10mA
Detector Clamping Diodes
$V_{DET} > 6V$ or $V_{DET} < 0.9V$ .... ±10mA
Error Amp, Multiplier, and Comparator Input Voltages .... -0.3V to 6V
Detector Input Voltage (Note 2) .... -0.3 to 6V
Operating Junction Temperature
Plastic (M and DM Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 Seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.
Note 2. With no limiting resistor.
Note 3. Current duty cycle is chosen such that T_J is below 150°C.

THERMAL DATA

M PACKAGE:

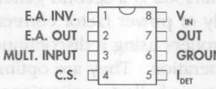
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

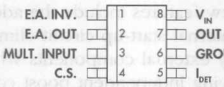
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

PACKAGE PIN OUTS



M PACKAGE
(Top View)



DM PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 4)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
Supply Voltage Range		11		25	V
Peak Driver Output Current			±200		mA
Operating Ambient Temperature Range:					
LX1562/1563		0		100	°C

Note 4. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX1562/1563 with $0°C \le T_A \le 100°C$; V_{IN}=12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX1562I/1563I			Units
			Min.	Typ.	Max.	
Under-Voltage Lockout Section						
Start Threshold Voltage	V_{ST}	LX1562 Only	12	13.1	14	V
		LX1563 Only	9.2	9.8	10.6	V
UV Lockout Hysteresis	ΔV_H	LX1562 Only	4	5.2	6	V
		LX1563 Only	1.7	2.1	2.5	V
Supply Current Section						
Start-Up Supply Current	I_{ST}	$V_{IN} < V_{TH}$		200	300	µA
Operating Supply Current	I_Q	V_{IN} = 12V, Output Not Switching		5	8	mA
Dynamic Operating Supply Current	I_{OP}	V_{IN} = 12V, 50kHz, CGS = 1000pF		6	10	mA
Reference Section (Note 5)						
Initial Accuracy (Note 8)	V_R	I_{REF} = 0mA, T_A = 25°C	2.465	2.50	2.535	V
		I_{REF} = 0mA	2.44		2.56	V
Line Regulation	ΔV_I	$12V < V_{IN} < 25V$		0.1		mV
Load Regulation	ΔV_L	$0 < I_{REF} < 2mA$		1.3		mV
Temperature Stability	ΔV_T			20		mV
Error Amplifier Section						
Input Bias Current	I_B		-500	50	500	nA
Large Signal Open Loop Voltage Gain	A_{VOL}	(Note 5)	60	80		dB
Slew Rate	S			0.63		V/µsec
Power Supply Rejection Ratio (Note 5)	PSRR	11 to 25V	60	80		dB
Output Source Current	I_{SR}	V_{OH} = 3V	-2	-4.5		mA
Output Sink Current	I_{SK}	V_{OL} = 2V	3	4.5		mA
Output Voltage Range (Note 7)	$E.A._O$	No Load on E.A. Output	1.2		3.8	V
Unity Gain Bandwidth	f_B			1.7		MHz
Phase Margin	ϕ_B			49		°
Multiplier Section						
Mult. Input Voltage Range	V_{M1}		0		2	V
M2 Input Voltage Range	V_{M2}		V_{REF}		V_{REF} + 1	V
Mult. Input Bias Current (M1)	I_{MB}			-0.24		µA
Multiplier Gain (Note 5 & 6)	K	V_{M1} = 1V, ΔV_{EA0} = 2.7V to 3.3V	0.55	0.68	0.8	V/V²
		ΔV_{M1} = 0.5V to 1.5V, $V_{EA0} = V_{REF}$ + 1V	0.55	0.61	0.75	V/V²
Multiplier Gain Temperature Stability	ΔK_T			-0.2		%/°C
Maximum Multiplier Output Voltage	V_{CLMP}	V_{M1} = 2V, V_{PIN1} = 0V	1.1	1.24	1.45	V

(Electrical Characteristics continue next page.)

ELECTRICAL CHARACTERISTICS (Con't.)

Parameter	Symbol	Test Conditions	LX1562I/1563I Min.	Typ.	Max.	Units
Current Sense Comparator Section						
Input Bias Current	I_{CSB}	$0V \leq V_{CS} \leq 1.7V$	-1	-0.3	1	µA
Current Sense Delay to Output	t_d	$E.A._{OUT} = 3.7V$, $V_{CS} = 0$ to $1.2V$, $V_{M1} = 1V$		280	500	ns
C.S. Blanking Time	t_{BLK}		0.4	0.9	1.2	µs
C.S. Input Offset Voltage	V_{OFF}	$V_{EA0} = 2.2V$, $V_{M1} = 0V$, $I_{DETC} = 0V$	-20	3	20	mV
Detect Section						
Input Voltage Threshold - High	V_{HI}		1.6	1.72	1.9	V
Hysteresis	H_D		180	240	300	mV
Input LO Clamp Voltage	V_{DL}	$I_{DET} = 100µA$	0.4	0.62	0.85	V
Input HI Clamp Voltage	V_{DZ}	$I_{DET} = 3mA$	7.0	7.8	8.6	V
Input Current	I_{DB}	$1V \leq V_{DET} \leq 6V$	-1	-0.2	1	µA
Input HI/LO Clamp Diode Current	I_{DMX}	$V_{DET} < 0.9V$, $V_{DET} > 6V$			±3	mA
Restart Timer Section						
Restart Time	t_{RST}			300		µsec
Output Driver Section						
Output High Voltage	V_{PRH}	$I_L = -10mA$, $V_{IN} = 12V$	8.5	9		V
Output Low Voltage	V_{PRL}	$I_L = 10mA$, $V_{IN} = 12V$		0.8	1	V
Output Rise Time	t_R	$C_L = 1000pF$		130	200	ns
Output Fall Time	t_f	$C_L = 1000pF$		50	120	ns
Maximum Output Voltage	V_{DRMX}	$V_{IN} = 20V$	13	13.8	15	V

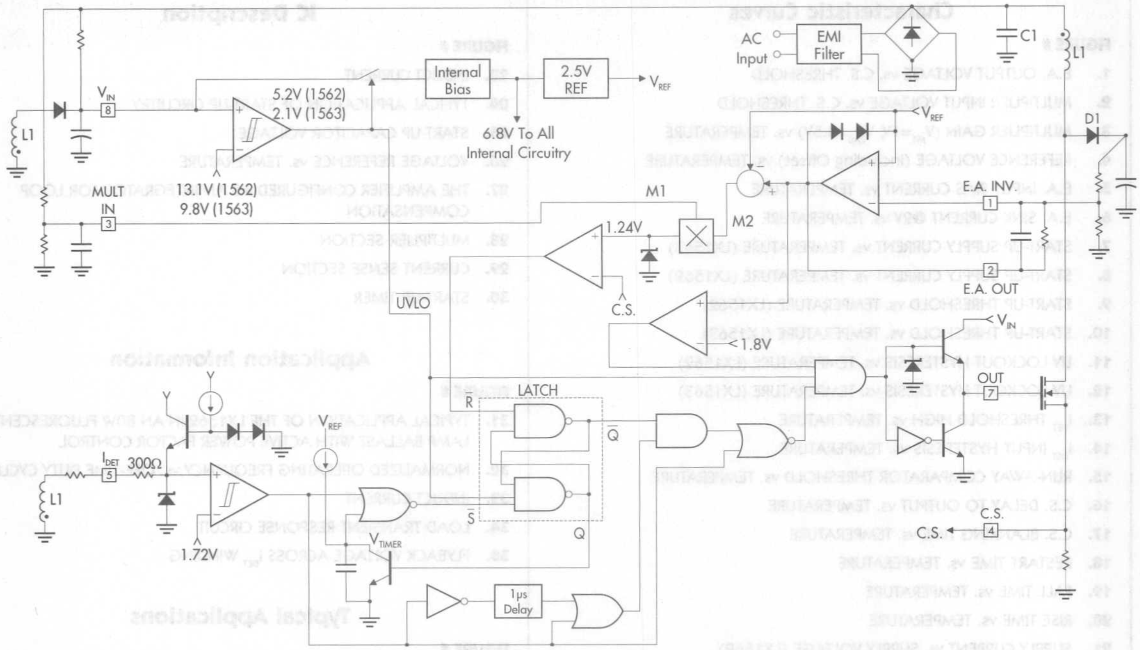
Notes: 5. Because the reference is not brought out externally, these specifications are tested at probe only, and cannot be tested on the packaged part. They are guaranteed by design, and shown for illustrative purposes only.

6. $$K = \frac{\Delta V_{C.S.}}{(\Delta V_{M1}) \times (V_{EA0} - V_{REF})} \approx \frac{\Delta V_{C.S.}}{(V_{M1})\,(\Delta V_{EA0})}$$

7. This parameter, although guaranteed, is not tested in production.
8. Initial accuracy includes input offset voltage of error amplifier.

LINFINITY MICROELECTRONICS

BLOCK DIAGRAM / PIN DESCRIPTIONS



FUNCTIONAL DESCRIPTION

Pin	#	Description
V_{IN}	8	Input supply voltage.
GND	6	Input supply voltage return. Must always be the lowest potential of all the pins.
INV	1	Inverting input of the Error Amplifier. The output of the Boost converter should be resistively divided to 2.5V and connected to this pin.
E.A. OUT	2	The output of the Error Amplifier. A feedback compensation network is placed between this pin and the INV pin.
MULT IN	3	Input to the multiplier stage. The full-wave rectified AC is divided to less than 2V and is connected to this pin.
C.S.	4	Input to the PWM comparator. Current is sensed in the Boost stage MOSFET by a resistor in the source lead, and is fed to this pin. An internal blanking circuit eliminates the RC low pass filter that otherwise is required to eliminate leading edge spike.
I_{DET}	5	A current driven logic input with internal clamp. A second winding on the Boost inductor senses the flyback voltage associated with the zero crossing of the inductor current and feeds it to the I_{DET} pin through a limiting resistor. Low on this pin causes V_O (pin 7) to go high.
OUT	7	PWM output pin. A totem-pole output stage specially designed for direct driving the MOSFET.

LINFINITY MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

IC Description

Application Information

Typical Applications

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — E.A. OUTPUT VOLTAGE vs. C.S. THRESHOLD

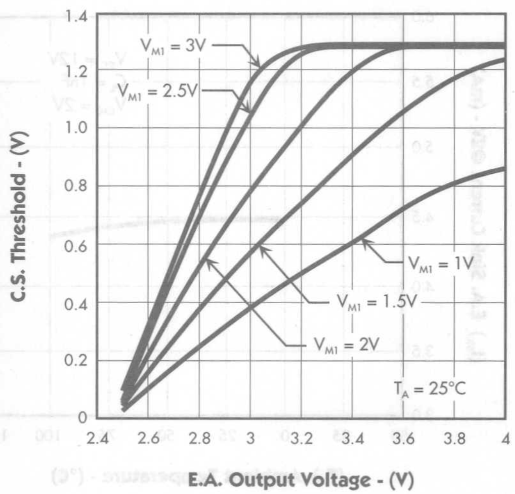


FIGURE 2. — MULTIPLIER INPUT VOLTAGE vs. C.S. THRESHOLD

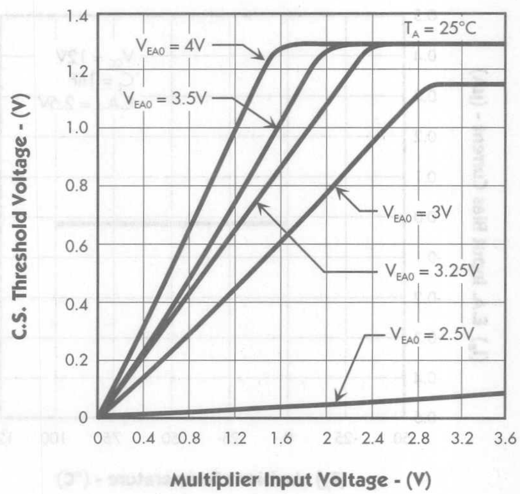


FIGURE 3. — MULTIPLIER GAIN (V_{M1}=1V, V_{EAO}=3.5V) vs. TEMPERATURE

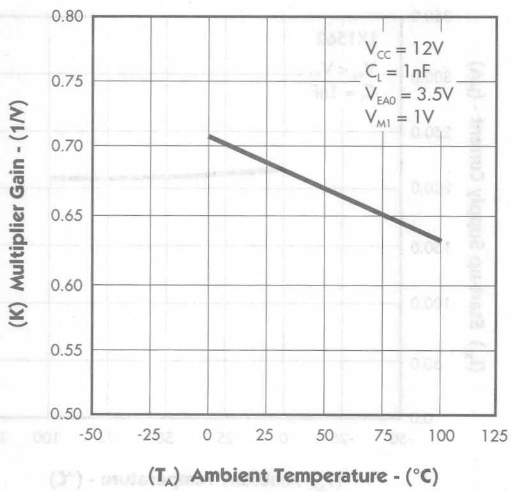
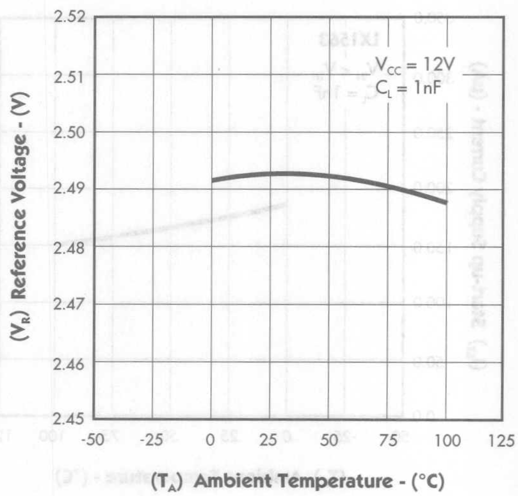


FIGURE 4. — REFERENCE VOLTAGE (Including Offset) vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 5. — E.A. INPUT BIAS CURRENT vs. TEMPERATURE

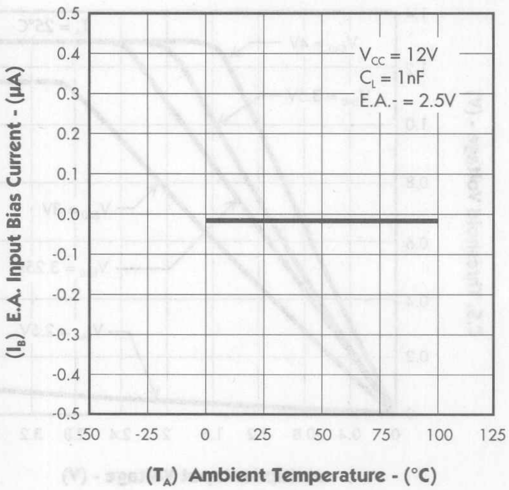


FIGURE 6. — E.A. SINK CURRENT @2V vs. TEMPERATURE

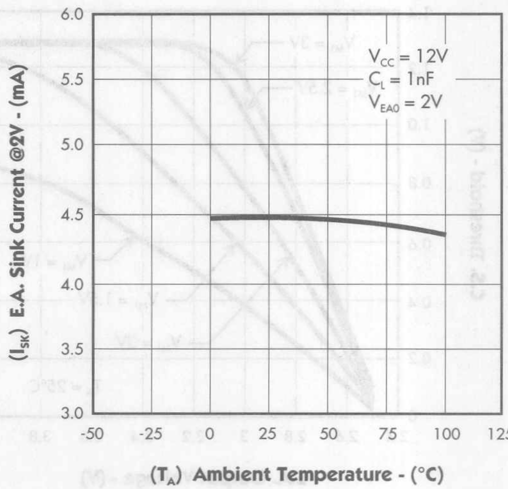


FIGURE 7. — START-UP SUPPLY CURRENT vs. TEMPERATURE

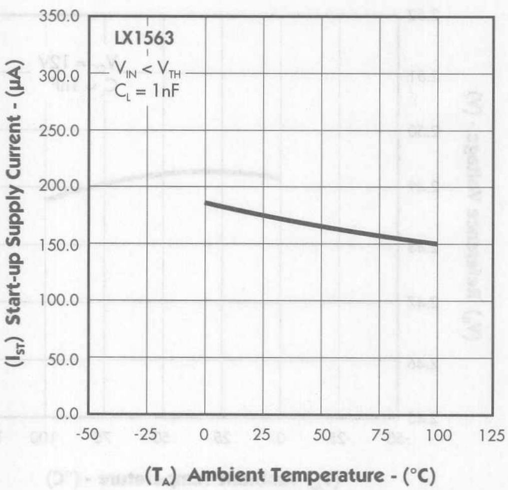
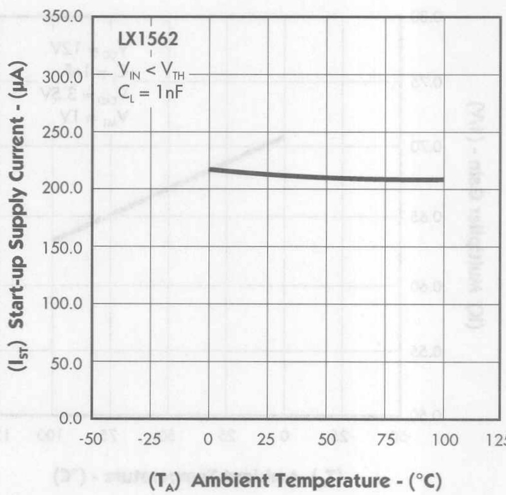


FIGURE 8. — START-UP SUPPLY CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 9. — START-UP THRESHOLD vs. TEMPERATURE

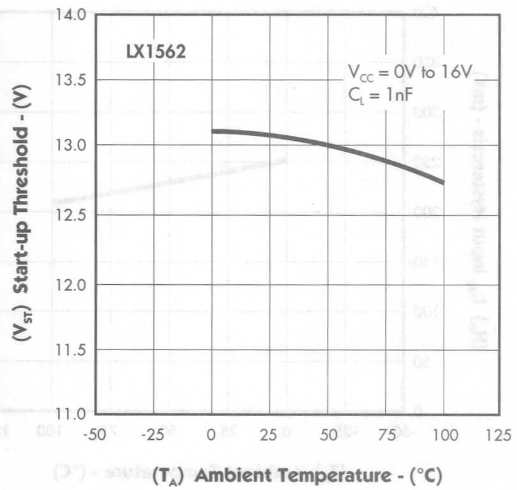


FIGURE 10. — START-UP THRESHOLD vs. TEMPERATURE

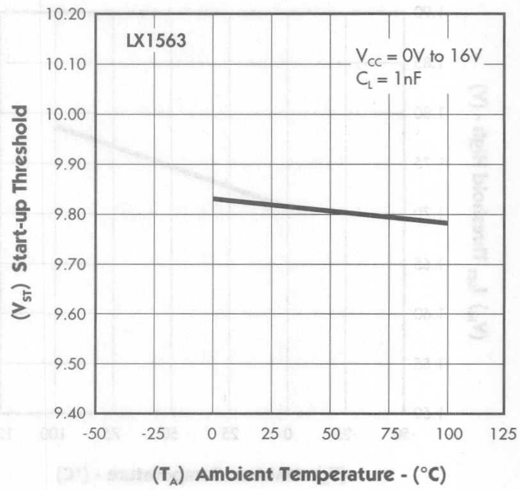


FIGURE 11. — UV LOCKOUT HYSTERESIS vs. TEMPERATURE

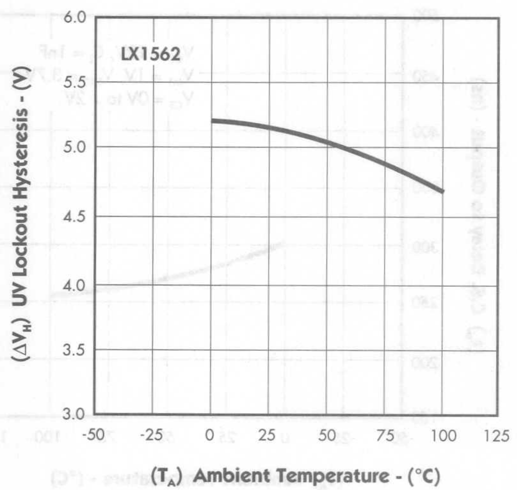
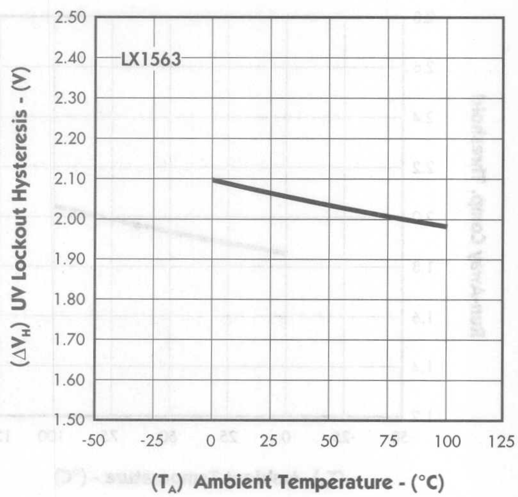


FIGURE 12. — UV LOCKOUT HYSTERESIS vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 13. — I_{DET} THRESHOLD HIGH vs. TEMPERATURE

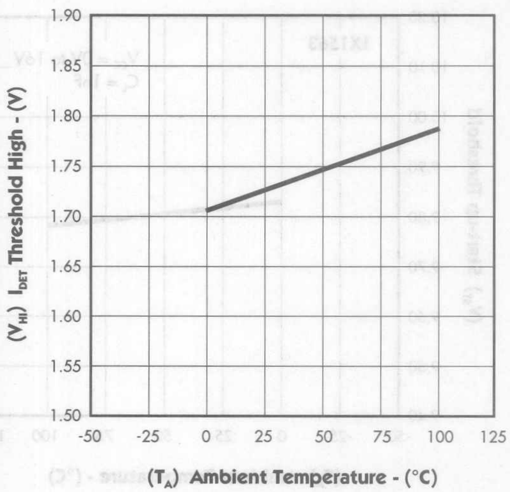


FIGURE 14. — I_{DET} INPUT HYSTERESIS vs. TEMPERATURE

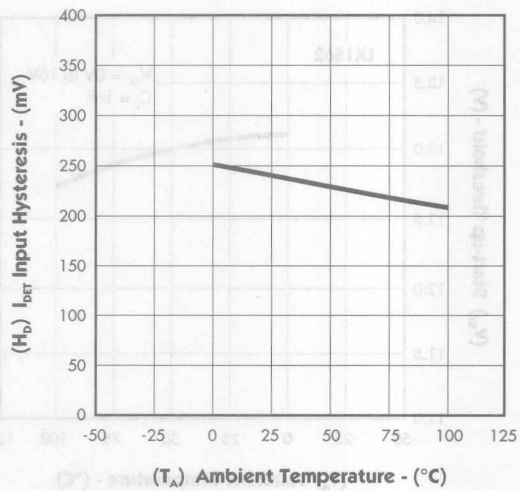


FIGURE 15. — RUN-AWAY COMPARATOR THRESHOLD vs. TEMPERATURE

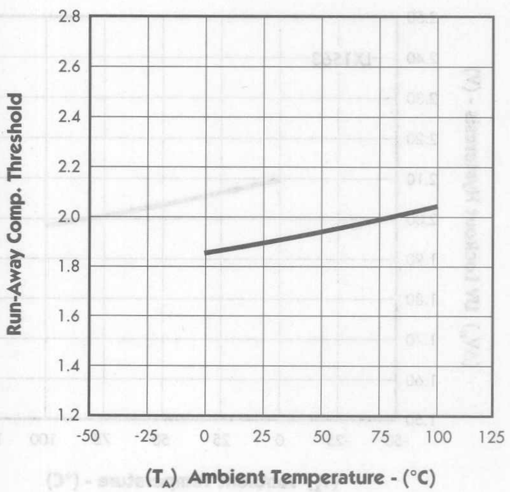
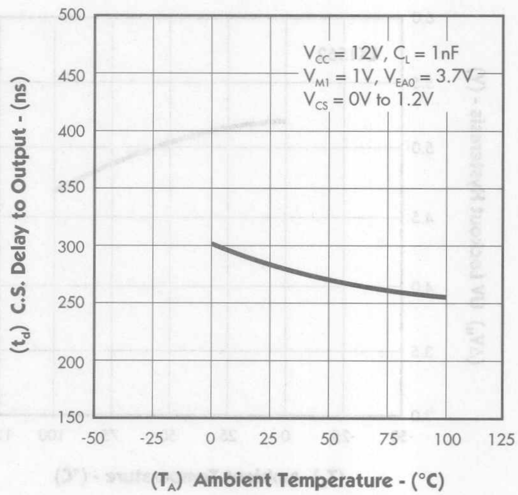


FIGURE 16. — C.S. DELAY TO OUTPUT vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 17. — C.S. BLANKING TIME vs. TEMPERATURE

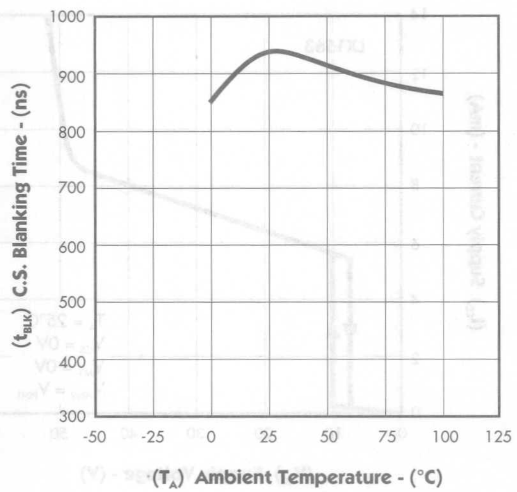


FIGURE 18. — RESTART TIME vs. TEMPERATURE

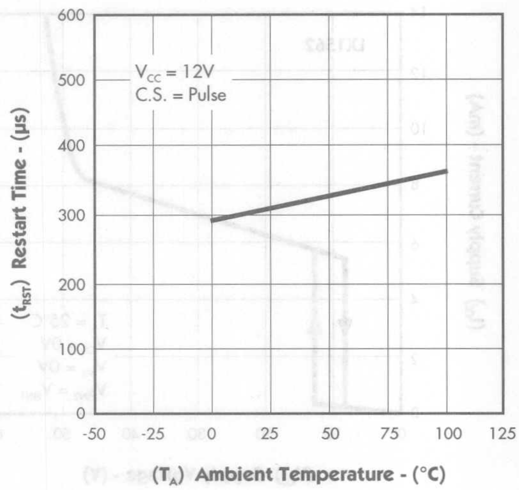


FIGURE 19. — FALL TIME vs. TEMPERATURE

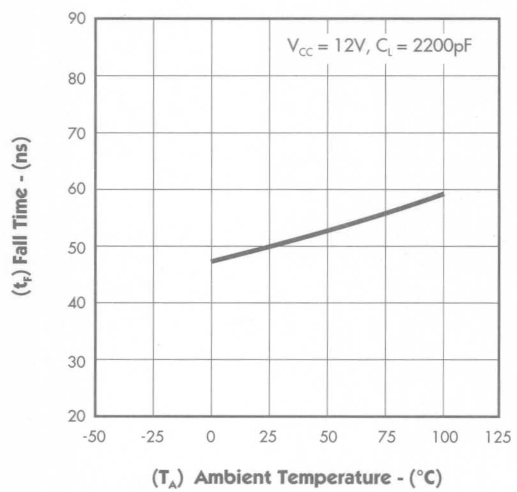
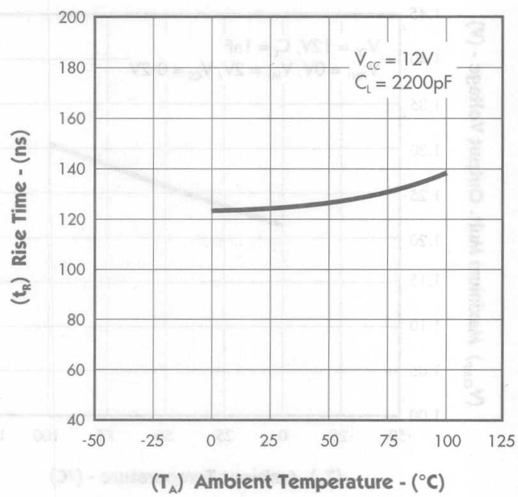


FIGURE 20. — RISE TIME vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 21. — SUPPLY CURRENT vs. SUPPLY VOLTAGE

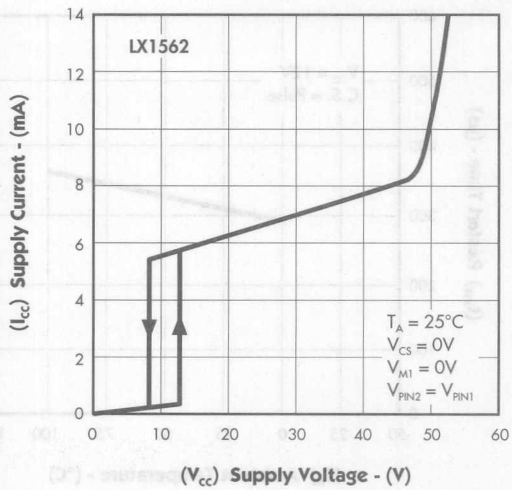


FIGURE 22. — SUPPLY CURRENT vs. SUPPLY VOLTAGE

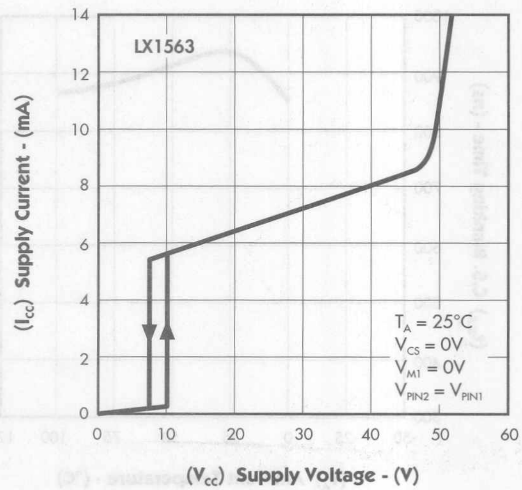
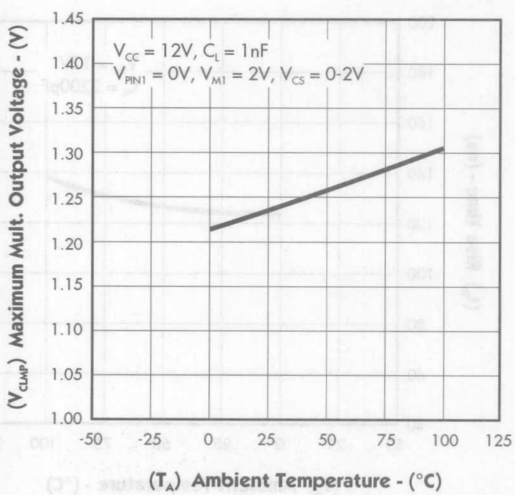


FIGURE 22a. — MAXIMUM MULTIPLIER OUTPUT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

FUNCTIONAL DESCRIPTION

The operation of the IC is best described by referring to the block-diagram. The output of the multiplier stage generates a voltage proportional to the product of the rectified AC line and the output of the error amplifier. This voltage serves as the reference for the inductor peak current that is sensed by the resistor in series with the external power MOSFET. When the sense voltage exceeds this threshold, C.S. comparator trips and resets the latch as well as turning the power MOSFET off.

The energy stored during switch on-time is now transferred and stored in the output capacitor, causing the inductor current to ramp down. When current reaches zero level (inductor runs out of energy) , boost diode (D1) stops conducting and the residual inductor energy and the drain to source capacitance of the power MOSFET create an LC tank circuit which causes drain voltage to resonate at this frequency. The resonating voltage is detected by the secondary winding (Idet winding) of the inductor. When this voltage swings negative "I detect" pin senses it and activates the blanking circuit , sets the latch, and turns power MOSFET on, repeating the cycle. This operation continues for the entire cycle of the AC rectified input resulting in an inductor current as shown in Figure 23. The high frequency content of this current is then filtered by the input capacitor (C1) resulting in a sine wave input current in phase with the AC line voltage.

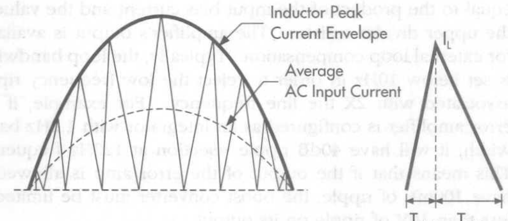


FIGURE 23 — INDUCTOR CURRENT

Output voltage regulation is accomplished when the error amplifier compares this voltage to an internal 2.5V reference and generates an error voltage. This voltage then controls the amplitude of the multiplier output adjusting the peak inductor current proportional to the load and line variations, maintaining a well regulated voltage.

IC DESCRIPTION

UNDERVOLTAGE LOCK OUT

The LX1562/63 undervoltage lock-out is designed to maintain an ultra low quiescent current of less than 300µA, while guaranteeing the IC is fully functional before the output stage is activated. Comparing this to the SG3561A device, a 40% reduction in start-up current is achieved, resulting in 40% less power dissipation in the start-up resistor. This is especially important in electronic ballast applications that are designed to operate in harsh environments, with convection cooling as the only means of heat dissipation.

Figure 24 shows an efficient supply voltage using the ultra low start-up current of the LX1562 in conjunction with a bootstrap winding off of the power transformer. Circuit operation is as follows:

The start-up capacitor (C1) is charged by current through resistor (R1) minus the start-up current drawn by the IC. This resistor is typically chosen to provide 2X the maximum start-up current at low line to guarantee start-up under the worst case condition. Once the capacitor voltage reaches the start-up threshold, the IC turns on, starting the switching cycle. The operation of the IC demands an increase in operating current which results in discharging the capacitor. During the discharge cycle, the flyback voltage of the auxiliary winding is rectified and filtered via rectifier (D1) and charges the capacitor above the minimum operating voltage of the device and takes over as the supply voltage. The start-up capacitor and auxiliary winding must be selected such that it satisfies worst case IC conditions. Figure 25 shows start-up time and voltage of capacitor C1.

Table 1 shows the start-up voltage and hysteresis for LX1562 and LX1563. The LX1562 is used for stand alone pre-regulator applications while LX1563 is ideal for applications where supply voltage is derived elsewhere and requires less than 14V start-up.

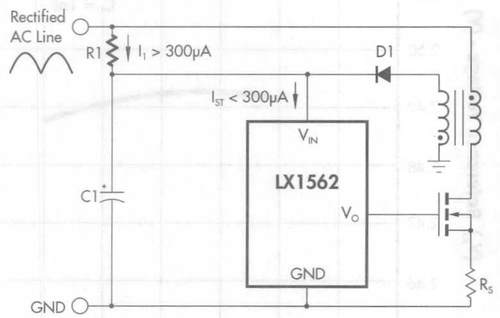


FIGURE 24 — TYPICAL APPLICATION OF START-UP CIRCUITRY

TABLE 1

Part #	Start-Up Voltage	Hysteresis Voltage
LX1562	13.1V	5.2V
LX1563	9.8V	2.1V

IC DESCRIPTION

VOLTAGE REFERENCE (continued)

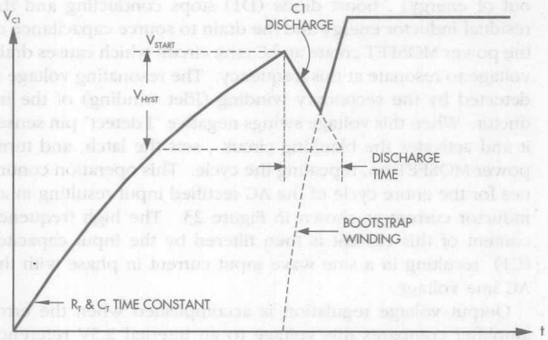


FIGURE 25 — START-UP CAPACITOR VOLTAGE

VOLTAGE REFERENCE

The voltage reference is a low drift bandgap design which provides a stable +2.5V output with maximum of ±1.5% initial accuracy. This voltage is internally tied to the non-inverting input of the amplifier and is not available for external connection. The initial accuracy of the reference includes error amplifier input offset voltage. Figure 26 shows typical variation of the reference voltage vs. temperature.

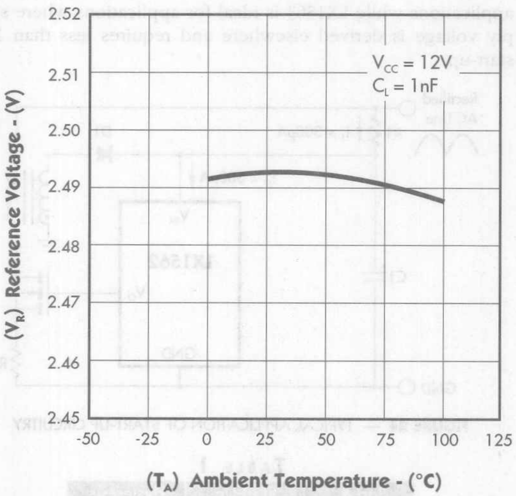


FIGURE 26 — REFERENCE VOLTAGE (Including Offset) vs. TEMPERATURE

ERROR AMPLIFIER

The error amplifier is an internally compensated op-amp with access to the inverting input and the output pin. The non-inverting input is internally connected to the voltage reference and is not available for external connection. The amplifier is designed for an open loop gain of 80dB, along with a typical bandwidth of 1.7MHz and 49 degrees of phase margin. The boost output voltage of the power factor pre-regulator is divided down and monitored by the inverting input. Input bias current (0.5μA max) can cause an output voltage error that is equal to the product of the input bias current and the value of the upper divider resistor. The amplifier's output is available for external loop compensation. Typically, the loop bandwidth is set below 10Hz in order to reject the low frequency ripple associated with 2X the line frequency. For example, if the error amplifier is configured as an integrator with 1.2Hz bandwidth, it will have 40dB ripple rejection at 120Hz frequency. This means that if the output of the error amp is allowed to have 100mV of ripple, the boost converter must be limited to less than 10V of ripple on its output.

To prevent boost output run away condition that may occur during removal of the output load, a separate comparator monitors the E.A. output voltage and compares it to an internal 1.8V reference. When load is removed, E.A. output swings lower than 1.8V, trips the comparator and turns output driver off till the inverting input voltage drops below 2.5V. At this point, the E.A. output swings positive, turns the output driver back on and repeats the cycle until the load is returned to normal condition.

To reduce output overshoot during line and load transients, the E.A. output is clamped to two diode drops above the reference voltage. This prohibits the amplifier from being saturated, allowing it to recover faster thus minimizing the boost voltage overshoot.

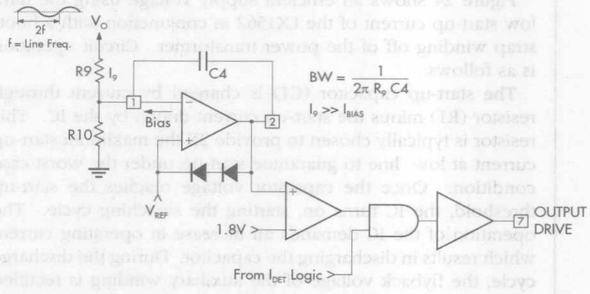


FIGURE 27 — THE AMPLIFIER CONFIGURED AS AN INTEGRATOR FOR LOOP COMPENSATION

IC DESCRIPTION

MULTIPLIER

The LX1562/63 features a one quadrant multiplier stage having two inputs. One (V_{M2}) is internally driven by a DC voltage which is the difference of E.A. output and V_{REF}. The other (V_{M1}), is connected to an external resistor divider monitoring the rectified AC line. The output of the multiplier which is a function of both inputs, controls inductor peak current during each cycle of operation. This allows the inductor peak current to follow the AC line thus forcing the average input current to be sinusoidal.

The multiplier is in the linear region if the V_{M1} input is limited to less than 2V and the E.A. output is kept below 3.5V under all line and load conditions. The output is internally clamped to 1.24V typically to limit the MOSFET peak current during turn on or under excessive load conditions. The equation below describes the relationship between multiplier output voltage and the its inputs.

$$V_{MO} = K * V_{M1} * (V_{EAO} - V_{REF})$$

where: K = Multiplier gain (typ. 0.65)
V_{M1} = Voltage at pin3 (0 to 2V)
V_{EAO} = Error amp output voltage (2.5 to 3.5V)
V_{MO} = Multiplier output voltage

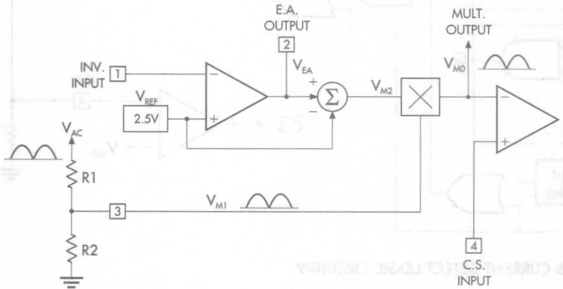


FIGURE 28 — MULTIPLIER SECTION

CURRENT SENSE COMPARATOR

Current sense comparator is configured as a PNP input differential stage with one input internally tied to the multiplier output and the other available for current sensing. Current is converted to voltage using an external sense resistor in series with the external power MOSFET. When sense voltage exceeds the threshold set by the multiplier output, the current sense comparator terminates the gate drive to the MOSFET and resets the PWM latch. The latch insures that the output remains in a low state after the switch current falls back to zero. The LX1562/63 features a leading edge blanking circuit that eliminates the need for an external RC filter otherwise required for proper operation of the circuit. This function is described in detail under "current detect logic" section.

The current sense comparator voltage is limited by an internal 1.24V (typ.) voltage clamp of the multiplier output. Therefore maximum switch current is typically given by:

$$I_{PK\ (MAX)} = 1.24V / R_S$$

Maximum switch peak current happens at full load and minimum line conditions.

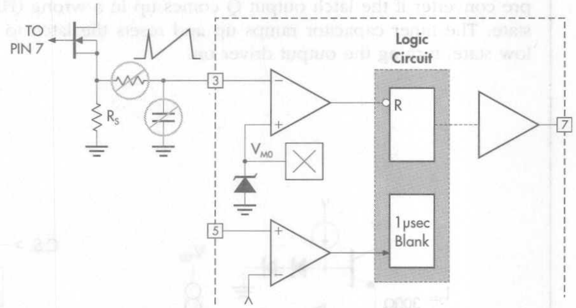


FIGURE 29 — CURRENT SENSE SECTION

CURRENT DETECT LOGIC

The function of "current detect logic" is to sense the operating state of the boost inductor and to enable the output driver accordingly. To achieve this, the downward slope of the inductor current is indirectly detected by monitoring the voltage across a separate winding and connecting it to the detector input "I_{DET}" pin. Once the inductor current reaches ground level, the voltage across the winding reverses polarity and changes the "I_{DET}" input and the comparator output to the low state (See Figure 30). When comparator changes state, it sets the latch and turns on the output driver for a period of 1µs (typ.) regardless of any changes in the latch output ($\overline{Q}$) within this period. This ensures that if the C.S. comparator changes state due to any turn-on spike, the driver output remains on and does not turn off prematurely.

However if the spike lasts longer than 1µs, the output driver turns off and the MOSFET stops conducting. This type of digital current sense blanking which is not amplitude dependent has higher noise immunity than the commonly used external RC filtering, allowing for more flexibility in board layout.

Since inductor voltage swings both positive and negative, internal voltage clamping is provided to protect the IC. The

IC DESCRIPTION

CURRENT DETECT LOGIC (continued)

upper 7.8V clamp prevents input overvoltage breakdown during switch off time, while during the on time the lower 0.7V clamp prevents substrate injection. An internal current limit resistor protects the lower clamp transistor in case the "I_{DET}" pin is accidently shorted to ground.

START-UP TIMER

A start-up timer circuit eliminates the need for an external oscillator when used in stand alone applications. The timer, as shown in Figure 30, provides a means to automatically start the pre converter if the latch output $\overline{Q}$ comes up in a wrong (HI) state. The timer capacitor ramps up and resets the latch to a low state, turning the output driver on.

OUTPUT DRIVER STAGE

The LX1562/63 output driver is designed for direct driving of an external power MOSFET. It is a totem pole stage with ±500mA peak current capability. This typically results in a 130ns rise and fall times into a 1000pF capacitive load. Additionally the output is held low during the undervoltage condition to ensure that the MOSFET remains in the off state until supply voltage reaches the start-up threshold.

Internal voltage clamping ensures that output driver is always lower than 13.8V (typ.) when supply voltage variation exceeds more than rated V_{GS} threshold (typ 20V) of the external MOSFET. This eliminates an external zener diode and extra power dissipation associated with it that otherwise is required for reliable circuit operation.

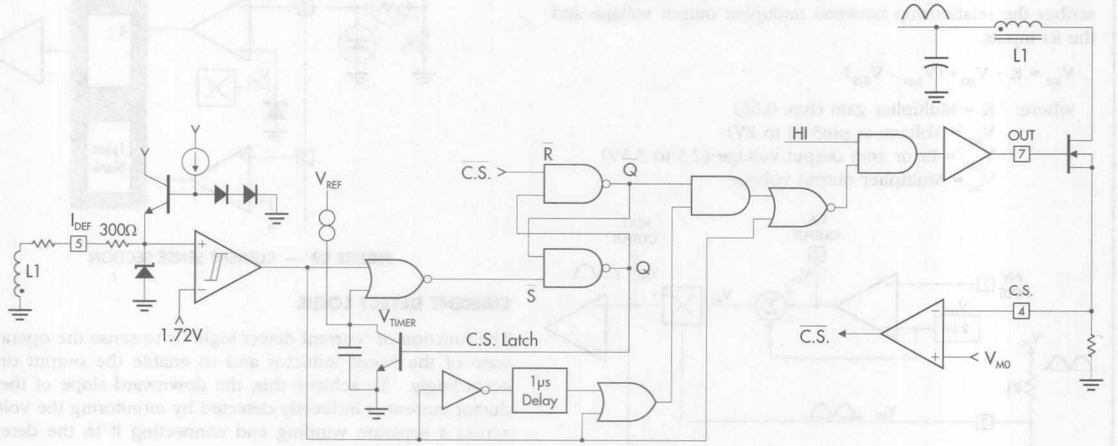


FIGURE 30 — START-UP TIMER & CURRENT DETECT LOGIC CIRCUITRY

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APPLICATION INFORMATION

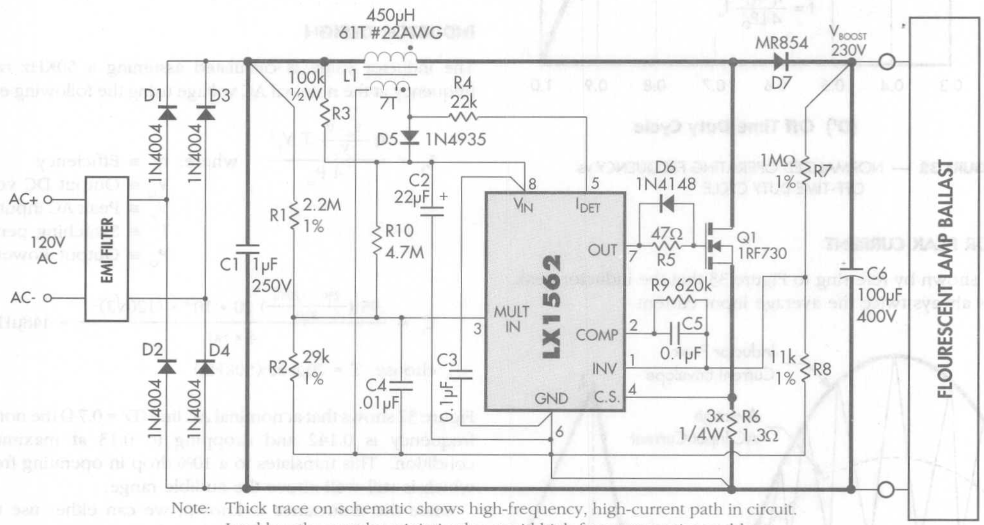
TYPICAL APPLICATION

The application circuit shown in Figure 31 uses the LX1562 as the controller to implement a boost type power factor regulator. The I.C. controls the regulator, such that the inductor current is always operating in a discontinuous conduction mode with no current gaps. This mode of operation has several advantages over the fixed frequency discontinuous conduction mode: 1) The switching frequency adjusts itself to the AC line envelope, causing a sinusoidal current draw, 2) Since there is no current gap between the switching cycles, the inductor voltage does not oscillate, causing less radiated noise, 3) The lower peak inductor current causes less power dissipation in the power MOSFET.

A set of formulas have been derived specifically for this mode, and are used throughout the design procedure. An example with the following specifications for the boost converter is given as:

Input Voltage Range	-	100 to 130V RMS
Output Power	-	80W
Efficiency	-	95% at full load
Power Factor	-	> 0.99 at full load
Total Harmonic Distortion	-	< 10% at full load

followed by a step by step design procedure which walks through component selection.



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

FIGURE 31 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL

OUTPUT VOLTAGE REQUIREMENT

Since the converter is a boost type topology, it requires the output voltage to always be higher than the input voltage. It is recommended to select this voltage at least 15% higher than the maximum input voltage in order to: A) Avoid the inductor saturation during line transience, and B) To keep the operating frequency above the audible range at high line.

Figure 32 (next page) shows that when boost voltage is selected near the maximum AC line, the increase in off-time could reduce the operating frequency below the audible frequency and cause inductor humming. In fact, Figure 32 (next page) shows that for ±13% (100V to 130V) change in the line voltage the optimum range of the operating frequency is when off-time duty cycle (D') is between 0.57 and 0.75. This means that the boost voltage needs to be 245V when selecting D' = 0.75 at maximum AC line.

In this example, D' is chosen to be 0.8, to slightly reduce the voltage rating of the back end DC to AC fluorescent lamp inverter. This sets the boost voltage at:

$$V_O = \frac{130 * \sqrt{2}}{0.8} = 230V$$

APPLICATION INFORMATION

OUTPUT VOLTAGE REQUIREMENT (continued)

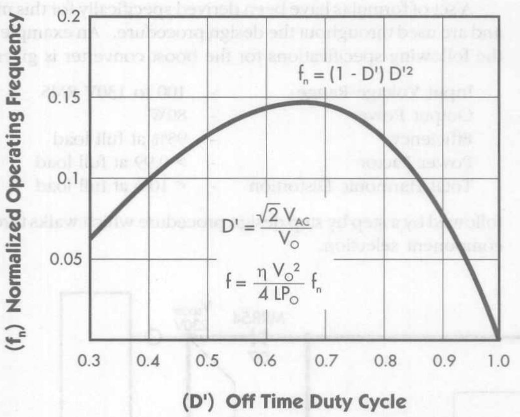


FIGURE 32 — NORMALIZED OPERATING FREQUENCY vs. OFF-TIME DUTY CYCLE

INDUCTOR PEAK CURRENT

It can be shown by referring to Figure 33 that the inductor peak current is always twice the average input current.

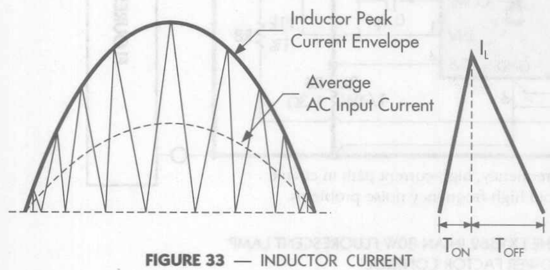


FIGURE 33 — INDUCTOR CURRENT

$$I_{IN(t)} = \sum AVE\,[\,I_L\,(t)\,]$$

$$I_{IN} = \frac{1}{T}\left[\frac{(I_L)\,(T)}{2}\right] = \frac{I_L}{2}$$

$$I_{INpeak} \equiv I_P = \frac{I_{LP}}{2}$$

I_{LP} = Inductor peak current at peak input voltage.

Maximum peak input current can be calculated using:

$$I_P = \frac{2P_O}{\eta V_P}$$

where: $\eta \equiv$ Converter efficiency
$V_P \equiv$ Peak AC input voltage

assuming: $\eta = 95\%$, $P_O = 80W$, $V_{Pmin} = 100\sqrt{2} = 141$

$$I_P = \frac{2 \times 80}{(.95)(141)} = 1.2A$$

$$I_{LP/min\ AC} = 2 \cdot 1.2 = 2.4A$$

INDUCTOR DESIGN

The inductor value is calculated assuming a 50KHz operating frequency at the nominal AC voltage using the following equation:

$$L_1 = \frac{\eta \frac{V_O - V_P}{V_O}\, T\, V_P^2}{4\, P_O}$$

where: $\eta \equiv$ Efficiency
$V_O \equiv$ Output DC voltage
$V_P \equiv$ Peak AC input voltage
$T \equiv$ Switching period
$P_O \equiv$ Output Power

$$L_1 = \frac{.95\left(\frac{230 - 120\sqrt{2}}{230}\right) 20 \cdot 10^{-6} \cdot (120\sqrt{2})^2}{4 \cdot 80} = 448\mu H$$

choose $T = 20\mu sec$ (50kHz)

Figure 32 shows that at nominal AC line (D' = 0.74) the normalized frequency is 0.142 and dropping to 0.13 at maximum line condition. This translates to a 10% drop in operating frequency which is still well above the audible range.

Once the inductance is known, we can either use the area product method (AP) or the K_g (based on copper losses method), for selecting proper core size. In this example, we apply the K_g approach using the following steps:

Step 1: Calculate K_g using

$$K_g = \frac{\Omega}{P_{CU}}\left(\frac{L_1 I_{LP}^2}{B}\right)^2$$

where: $L_1 \equiv$ Required inductance
$\Omega \equiv 1.724 \cdot 10^{-8}$ m
$B \equiv$ Maximum flux density
$I_{LP} \equiv$ Maximum peak inductor current
$P_{CU} \equiv$ Maximum copper dissipation

Assume: $P_{CU} = 1.6W$ (2% of total output)

$$K_g = \frac{1.724 \cdot 10^{-8}}{1.6}\left[\frac{450 \cdot 10^{-6} \cdot (2.4)^2}{0.15}\right]^2 = 3.21 \cdot 10^{-12}\ m^5$$

APPLICATION INFORMATION

INDUCTOR DESIGN (continued)

Step 2: Choose a core with higher K_g than the one calculated in Step 1.

$$K_g/\text{core} = k\,\frac{A_W A_E^2}{l_W}$$

where: $k \equiv$ Winding coefficient (typ. k=0.4)
$A_W \equiv$ Bobbin window area
$A_E \equiv$ Effective core area
$l_W \equiv$ Mean length per turn

K_g factor for TDK PQ2625:
$A_W = 47.7\text{mm}^2$
$A_E = 118\text{mm}^2$
$l_W = 56.2\text{mm}$

$$K_g = 0.4\,\frac{(47.7)\,(118)^2}{56.2}\,(\text{mm})^5 = 4.7 * 10^{-12}\ \text{m}^5$$

Step 3: Determine number of turns.

$$N = \frac{L\,I_{LP}}{B\,A_E}$$

$$N = \frac{450 * 10^{-6} * 2.4}{0.15 * 118 * 10^{-6}} = 61\ \text{turns}$$

$$A_{WIRE} = k\,\frac{A_W}{N} = 0.4\,\frac{47.7}{61} = 0.31\text{mm}^2 = 480\text{mil}^2$$

choose #22 AWG with r = 0.0165Ω/feet resistance.

$R_W = N * l_W * r$
$R_W = 0.185\Omega$

Step 4: Calculate air gap.

$$l_g = \frac{\mu_O\,N^2\,A_E}{L}$$

$$l_q = \frac{4\pi * 10^{-7} * (61)^2 * 118 * 10^{-6}}{450 * 10^{-6}} = 0.122\text{cm} = 48\ \text{mil}$$

CURRENT SENSE RESISTOR

Current sense resistor, R6 is selected using the minimum multiplier output clamp voltage and the maximum inductor peak current such that:

$$R6 = \frac{V_{CLAMP(MIN)}}{I_{L\,(MAX)}} = \frac{1.1}{2.4} = 0.45\Omega$$

Power dissipation is approximated by:

$$P_R \approx \frac{1}{6}\,I_{2\,(MAX)}^{\ 2}\,(1 - D'_{MIN}), \quad \text{where } D'_{MIN} = 1 - \frac{\sqrt{2}\,V_{AC(MIN)}}{V_{BOOST}}$$

$$P_R \approx \frac{1}{6}\,(2.4)^2\ (1 - 0.61) = 0.374$$

Select **THREE** 1.3Ω, ¼W carbon comp resistors in parallel.

MULTIPLIER COMPONENT SELECTION

Calculate R1 & R2 resistor values such that under low line AC input the multiplier output is lower than the minimum clamp voltage.

$$\frac{R2}{R1 + R2} * \sqrt{2}\,V_{AC\,(MIN)} * K * (V_{EA0\,(MAX)} - V_{REF}) < V_{CLAMP\,(MIN)}$$

where: $K \equiv$ Mult. Gain
$V_{EA(MAX)} \equiv$ Maximum error amp output where multiplier is still in linear range. This voltage is ≈ 3.5V.

For K = 0.65 & $V_{CLAMP\,(MIN)}$ = 1.1V, the ratio of R1/R2 is:

$$\frac{R1}{R2} > 83$$

Assuming R1 is selected to be:

***R1 = 2.2M (1%)**

$R2 = \frac{2.2M}{83}$ = **26.4k (1%)** select **R_2 = 26.7k (1%)**

* For high input applications such as 277V, R1 must be divided into two resistors in series to meet the maximum rated voltage of the resistors.

To improve THD further (typ. 2-3%), a high value resistor can be connected from the supply voltage to this pin to allow an increase in the switch on-time at the zero crossing by adding an effective offset at the multiplier output.

ERROR AMPLIFIER COMPONENT SELECTION

Boost voltage is programmed with R7 & R8 resistor dividers using the following equation:

$$\frac{R7}{R8} = \frac{V_{BOOST}}{V_{REF}} - 1,$$

assuming that the product of R7 and the E.A. input bias current does not cause significant error in the output voltage setting.

Assuming **R7 = 1MΩ** (for output voltage of higher than 250V, two resistors may be added in series to meet the voltage requirement of the resistor.)

ΔV_{ERROR} (10⁶) (0.5 * 10⁻⁶) = 0.5V, which is < 0.25% of the output voltage.

Calculating R8:

$$R8 = \frac{R7}{\frac{V_{BOOST}}{V_{REF}} - 1} = \mathbf{11k\ \ (1\%)}$$

Worst case output tolerance is the total of ±3.75% which is the sum of ±1.5% (Ref), ±2% (resistor dividers), and ±0.25% (E.A. input bias current).

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

ERROR AMPLIFIER COMPONENT SELECTION (continued)

Capacitor C5 is primarily selected to reject the output ripple associated with twice the line frequency. For a 40dB ripple rejection:

$$C5 \geq \frac{100}{2\pi f_l R7} \quad \text{where } f_l = 2\text{x line frequency}$$

$$C5 \geq \frac{100}{2\pi * 120 * 2.2 * 10^6} = 0.062\mu F, \quad \text{Select } \mathbf{C5 = 0.1\mu F}$$

Resistor R9 can be used to improve load transient response at the cost of loosing 1 or 2% of load regulation. The value of this resistor should be much greater than R8:

R9 = 620k

One way of achieving desired load transient response without resorting to a complex mathematical model of the converter, is to dynamically switch the output load and empirically find the compensation network. The value of resistor R9 is selected using the method shown in Figure 34.

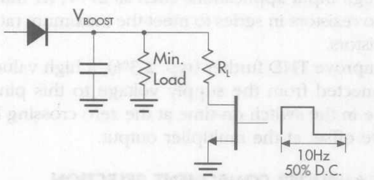


FIGURE 34 — LOAD TRANSIENT RESPONSE CIRCUIT

I_{DETECT} COMPONENT SELECTION

Figure 35 shows voltage envelope generated by flyback voltage across I_{DET} winding:

Select turns ratio n such that,

$$n = \frac{5V}{V_{BOOST} - \sqrt{2}\, V_{AC\,(MAX)}}$$

$$n = \frac{5V}{230 - \sqrt{2} * 130} = 0.11$$

I_{DET} winding turns are selected to be 7T.

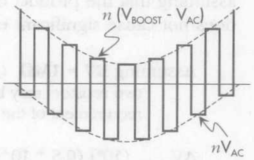


FIGURE 35 — FLYBACK VOLTAGE ACROSS I_{DET} WINDING

and R4 resistor:

$$\frac{n * V_{BOOST}}{3 * 10^{-3}} < R4 < 500k$$

$$\frac{0.11 * 230}{3 * 10^{-3}} < R4 < 500k, \text{ or} \qquad 8.4k < R4 < 500k$$

Select **R4 = 22k**

SUPPLY VOLTAGE

Resistor R3 must be selected such that it ensures converter start-up at low line and is rated for high line power dissipation.

$$R3 < \frac{\sqrt{2}\, V_{AC\,(MIN)}}{I_{ST\,(MAX)}}$$

where:
- I_{ST} ≡ Maximum start-up current
- V_{ST} ≡ Start-up voltage
- $T_{ST(MAX)}$ ≡ Maximum start-up time at AC power-on

$$R3 < \frac{\sqrt{2} * 100}{0.3 * 10^{-3}} = 466k\Omega$$

$R3 > 4\, V_{AC\,(MAX)}$ (to keep power dissipation below 0.5W)

$R3 > 68k$, select **R3 = 120k.**

Start-up time of converter is given by:

$$T_{ST\,(MAX)} \approx C2 \frac{V_{ST}}{\frac{\sqrt{2}\, V_{AC\,(MIN)}}{R3} - I_{ST}}$$

for our application this will be 25ms/µF.

The start-up capacitor is selected such that capacitor discharge time is always longer than the time it takes for the bootstrap voltage to reach above the minimum start-up threshold of the IC.

$$C3 < \frac{I_{OP} * \Delta t}{\Delta V_{MIN}}$$

where:
- I_{OP} ≡ Maximum dynamic supply current of the IC
- Δt ≡ Rise time of the bootstrap voltage
- ΔV_{MIN} ≡ Minimum hysteresis voltage (4V for 1562, 1.7V for 1563)

$$C3 < \frac{10 * 10^{-3} * 10 * 10^{-3}}{4} = 29\mu F$$

Select **C3 = 33µF.**

Start-up time is approximately 0.8 seconds.

The auxiliary winding turns are selected such that it provides 15V of operating voltage.

$$N_S \approx N_P * \frac{V_S}{V_O} = 61 * \frac{V_S}{V_O} = 4T$$

However, in this example I_{DETECT} winding is used to power the IC which eliminates the need for a third winding. This is possible since the internal clamping of the output drive limits the gate drive voltage to 14V (typ.) if the supply voltage exceeds this limit.

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

POWER MOSFET SELECTION

The voltage rating of MOSFET and rectifier must be higher than the maximum value of the output voltage.

$V_{DS} \geq 1.2\, V_{O\,MAX}$ $\qquad V_{DS} \geq 282V$

The RMS current can be approximated by multiplying the RMS current at the peak of the line by 0.7.

$I_{RMS} = 0.7\, I_{LP}\, \sqrt{D/3}$ $\qquad D \equiv$ On-time duty cycle

$D = 0.39$ at $V_{AC} = 100V$

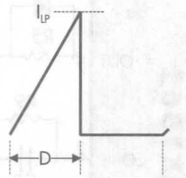
$I_{LP} = 2.4A$

$I_{RMS} = (0.7)(2.4)(\sqrt{.39/3}) = 0.61A$

$$R_{DS} \leq \frac{P_{DC}}{I_{RMS}^{\;2}}$$

$P_{DC} \equiv$ allowable power dissipation.

$$R_{DS} \leq \frac{1}{0.61} = 1.6\Omega$$



I_{RMS}/triangle $= I_{LP}\, \sqrt{D/3}$

IRF730 with R_{DS} = 1Ω and V_{DS} = 400V meets the above requirements.

INPUT RECTIFIER AND CAPACITOR SELECTION

The current through each diode is a half-wave rectified sine wave. The maximum current happens at minimum line with a peak value of 1.2A.

$$I_{AVE} = \frac{I_{PEAK}}{\pi} = \frac{1.2}{\pi} = 0.38A$$

choose **1N4004 with 1A rating.**

$P_{DISS} = (I_{AVE})\,(V_F) = 0.38 \times 0.9 = 0.344W$

$T_J = T_A + P_D \times \theta_{JA}$ $\qquad$ assuming $\theta_{JA} = 65°C/W$ for 1/8" lead length.

$T_J = 80 + (.344)(65) = 102°C$

Assuming φ is the percentage of allowable input current ripple, C1 can be calculated using the following equations:

$$R_{EFF} = \frac{2\,P_O}{\eta\, I_P^{\;2}}$$

$$C1 \geq \frac{1}{\varphi\, 2\pi\, R_{EFF}\, f_{SW}}$$

$f_{SW} \equiv$ Switching frequency of inductor current at peak input voltage.

if $\varphi = 3\%$

$$R_{EFF} = \frac{2 \times 80}{(.95)(1.2)^2} = 117\Omega$$

$$C1 \geq \frac{1}{(.03)(2\pi)(117)(50000)} = 0.9\mu F$$

choose **1µF, 250V capacitor**.

OUTPUT CAPACITOR SELECTION

There are mainly two criteria for selecting the output capacitor: A large enough capacitance to maintain a low ripple voltage, and a low ESR value in order to prevent high power dissipation due to RMS currents.

The output capacitance can be approximated from the following equation:

$$C6 \geq \frac{I_{DC}}{2\pi\, f_{LINE}\, \Delta V}$$

where: $I_{DC} \equiv$ DC output current
DV ≡ Output ripple

$$I_{DC} = \frac{80}{230} = 0.348A$$

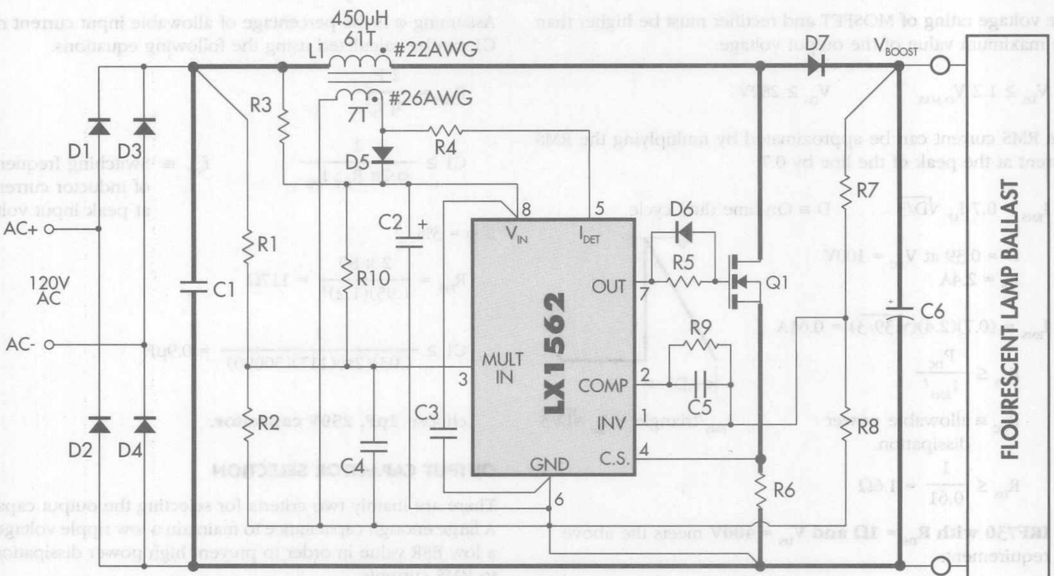
assuming 5% peak to peak ripple,

$$C6 \geq \frac{0.348}{2\pi\,(60)\,(11.5)} = 81\mu F$$

choose **C6 = 100µF**.

TYPICAL APPLICATIONS

120V



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

FIGURE 36 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

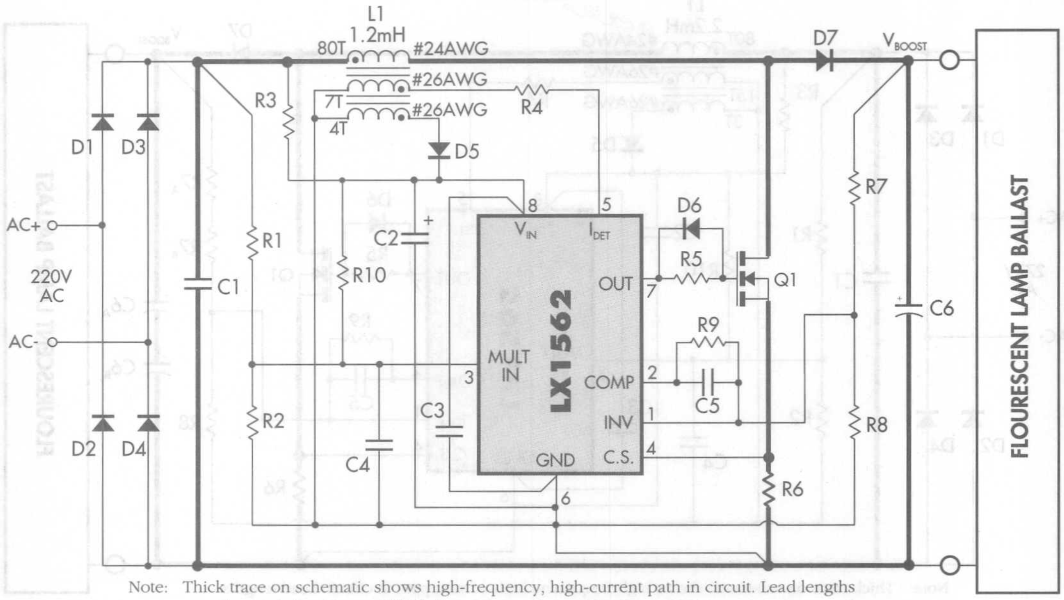
Electrical Specifica- **120VAC Input — 230VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	LX1562	Linfinity	C1	QXF2E105KRPT 1µF/250V - Plastic Film (high freq.)	Nichicon
L1	PQ2625/H7C1 Core	TDK			
Q1	IRF730, 400V, 1Ω rds	I.R.	C2	22µF/35V - Electrolytic	
D1-D4	IN4004 1A, 400V	Motorola	C3	0.1µF/50V - Ceramic	
D5	1N4935 1A	Motorola	C4	0.01µF/50V - Ceramic	
D6	1N4148 (improves Q1 power dissipation)	Motorola	C5	0.1µF/50V - Ceramic	
D7	MR854, 3A, 400V	Motorola	C6	LGQ2G101MHS A/Z* 100µF/400V - Electrolytic	Nichicon
R1	2.2MΩ, ±1%				
R2	26.7kΩ, ±1%				
R3	100kΩ, ½W			* A = 25mm diam. Z = 22mm diam.	
R4	22kΩ				
R5	47Ω				
R6	1.5Ω, Carbon type (3X)				
R7	1MΩ, 1%				
R8	11kΩ, 1%				
R9	620kΩ (improves load transient response)				
R10	4.7MΩ				

A complete evaluation board is available from Linfinity Microelectronics Inc.

TYPICAL APPLICATIONS

220V



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

FIGURE 37 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

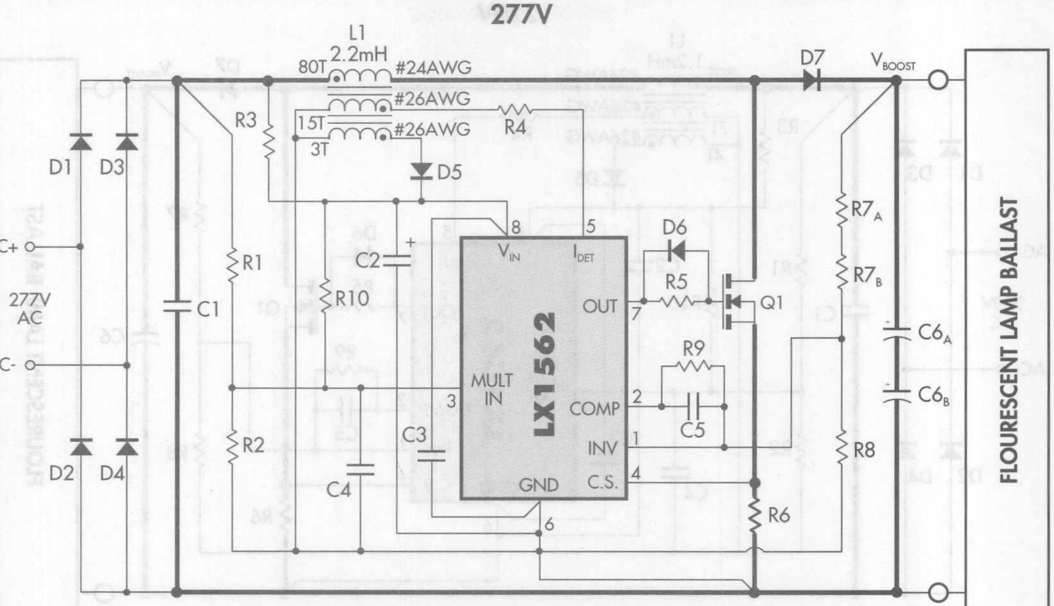
Electrical Specifica- **220VAC Input — 400VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	LX1562	Linfinity	C1	QXF2J224KRPT	
L1	PQ2625/H7C1 Core	TDK		0.22µF/630V - Plastic Film	Nichicon
Q1	IRF830, 500V, 1.5Ω rds	I.R.	C2	22µF/35V - Electrolytic	
D1-D4	IN4007 1A, 1000V	Motorola	C3	0.1µF/50V - Ceramic	
D5	1N4935 1A	Motorola	C4	0.01µF/50V - Ceramic	
D6	1N4148 (improves Q1 power dissipation)	Motorola	C5	0.1µF/50V - Ceramic	
D7	MR856, 3A, 600V	Motorola	C6*	LGQ2W680MHS A/Z*	Nichicon
R1	2.2MΩ, ±1%			68µF/450V - Electrolytic	
R2	12kΩ, ±1%				
R3	220kΩ, ½W			* A = 25mm diam.	
R4	22kΩ			Z = 22mm diam.	
R5	47Ω				
R6	1.8Ω, Carbon type (2X)				
R7	1MΩ, 1%				
R8	6.19kΩ, 1%				
R9	620kΩ (improves load transient response)				
R10	2.7MΩ				

A complete evaluation board is available from Linfinity Microelectronics Inc.

TYPICAL APPLICATIONS

277V



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

FIGURE 38 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specifica-

277VAC Input — 480VDC / 80W Output

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	LX1562	Linfinity	C1	QXF2J224KRPT	
L1	PQ2625/H7C1 Core	TDK		0.22µF/630V - Plastic Film	Nichicon
Q1	IRF830, 500V, 1.5Ω rds	I.R.	C2	22µF/35V - Electrolytic	
D1-D4	IN4007 1A, 1000V	Motorola	C3	0.1µF/50V - Ceramic	
D5	1N4935 1A	Motorola	C4	0.01µF/50V - Ceramic	
D6	1N4148 (improves Q1 power dissipation)	Motorola	C5	0.22µF/50V - Ceramic	
D7	MR856, 3A, 600V	Motorola	C6	UVZ2F470MEH (2X)	Nichicon
R1	2.2MΩ, ±1%			47µF/315V - Electrolytic	
R2	10kΩ, ±1%				
R3	390kΩ, ½W				
R4	22kΩ				
R5	47Ω				
R6	2.2Ω, Carbon type (2X)				
R7	499kΩ, 1% (2X)				
R8	5.23kΩ, 1%				
R9	620kΩ (improves load transient response)				
R10	2.2MΩ				

A complete evaluation board is available from Linfinity Microelectronics Inc.

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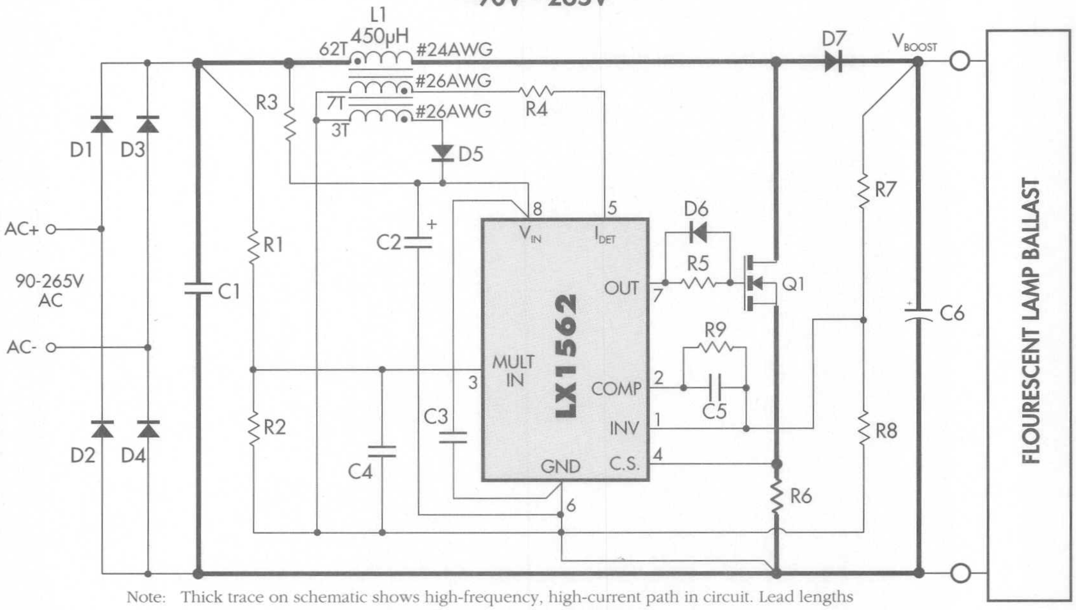
TYPICAL APPLICATIONS

90V - 265V



Note: Thick trace on schematic shows high-frequency, high-current path in circuit. Lead lengths must be minimized to avoid high-frequency noise problems.

FIGURE 39 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specifica-

90-265VAC Input — 400VDC / 80W Output

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	LX1562	Linfinity	C1	QXF2J224KRPT	
L1	PQ2625/H7C1 Core	TDK		0.47µF/630V - Plastic Film	Nichicon
Q1	IRF840, 500V, 1Ω rds	I.R.	C2	22µF/35V - Electrolytic	
D1-D4	IN4007 1A, 1000V	Motorola	C3	0.1µF/50V - Ceramic	
D5	1N4935 1A	Motorola	C4	0.01µF/50V - Ceramic	
D6	1N4148 (improves Q1 power dissipation)	Motorola	C5	0.33µF/50V - Ceramic	
D7	MR856, 3A, 600V	Motorola	C6*	LGQ2W680MHS A/Z*	Nichicon
R1	2.2MΩ, ±1%			68µF/450V - Electrolytic	
R2	16.3kΩ, ±1%				
R3	130kΩ, ½W			* A = 25mm diam.	
R4	22kΩ			Z = 22mm diam.	
R5	47Ω				
R6	1Ω, Carbon type (4X)				
R7	1MΩ, 1%				
R8	6.19kΩ, 1%				
R9	620kΩ (improves load transient response)				

A complete evaluation board is available from Linfinity Microelectronics Inc.

LINFINITY MICROELECTRONICS

Notes

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THE INFINITE POWER OF INNOVATION

LX1570/1571

PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

PRELIMINARY DATA SHEET

DESCRIPTION

The LX1570/71 series of controller ICs are designed to provide all control functions in a secondary-side regulator for isolated auxiliary or secondary power supplies. Auxiliary or secondary-side controllers are used in a variety of applications including multiple output off-line power supplies, commonly found in desktop computers, as well as telecommunications applications. Although they can be used in all secondary output applications requiring precision regulation, they are mainly optimized for outputs delivering more than 3A current where standard three-terminal regulators lack the desired efficiency. For these applications, the Mag Amp regulators have traditionally been used. However, Mag Amps have several disadvantages. First, because they have to withstand the maximum input voltage during a short-circuit condition, they are "over designed", typically by 2 times, increasing the cost and size of the power supply. Second, Mag Amps are inherently leading edge modulators, so they can only approach a certain maximum duty cycle, limited by the minimum delay and the magnetic BH loop characteristic of the Mag Amp core. This forces an increase in the size of the main transformer as well as the output inductor, resulting in higher overall system cost. **The LX1570/71 eliminates all the disadvantages of the Mag Amp approach as well as improving system performance and reducing overall system cost.**

The LX1570/71 is a current mode controller IC that controls the duty cycle of a switch in series with the secondary AC output of the power transformer in buck-derived applications, such as forward or bridge topologies. It offers features such as 100% duty cycle operation for maximum energy transfer, pulse-by-pulse and hiccup current limiting with long off-time between the cycles for reduced power dissipation, high-frequency operation for smaller magnetics, soft-start, and current mode control for excellent dynamic response.

KEY FEATURES

- REPLACES COSTLY MAG-AMP CORES WITH A LOW ON-RESISTANCE MOSFET
- **LOOK-AHEAD SWITCHING™** ENSURES SWITCH TURN ON BEFORE THE AC INPUT TO ACHIEVE 100% ENERGY TRANSFER
- LOWER OVERALL SYSTEM COST
- LOWER PEAK CURRENT STRESS ON THE PRIMARY SWITCH
- ALLOWS HIGHER OPERATING FREQUENCY AND SMALLER OUTPUT INDUCTOR
- EASY SHORT-CIRCUIT PROTECTION
- CURRENT MODE APPROACH ACHIEVES EXCELLENT DYNAMIC RESPONSE

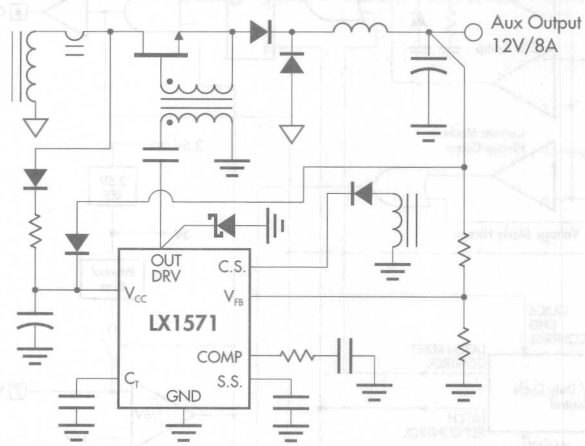
APPLICATIONS

- SECONDARY-SIDE REGULATOR IN OFF-LINE POWER SUPPLIES
- COMPUTER POWER SUPPLIES, 3.3V OUTPUT FOR NEW LOW-VOLTAGE PROCESSORS AND MEMORIES
- TELECOMMUNICATION AND MILITARY DC/DC CONVERTERS

AVAILABLE OPTIONS PER PART

Part #	C.L. Threshold	C.S. Option	Application
LX1570	-0.2V	Resistive Sensing	Output Currents < 4A
LX1571	1V	Current Transformer Sensing	Output Currents > 4A

PRODUCT HIGHLIGHT



PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	Y Ceramic DIP 8-pin
0 to 70	LX157xCM	LX157xCDM	—
-40 to 85	LX157xIM	LX157xIDM	—
-55 to 125	—	—	LX157xMY

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX157xCDMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX1570/1571

PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

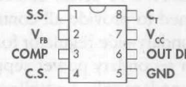
PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

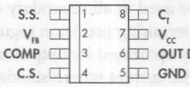
Supply Voltage (V_{CC})	40V
Digital Inputs	-0.3 to 7V
Output Peak Current Source (500nS)	1A
Output Peak Current Sink (500nS)	1A

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)



DM PACKAGE
(Top View)

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

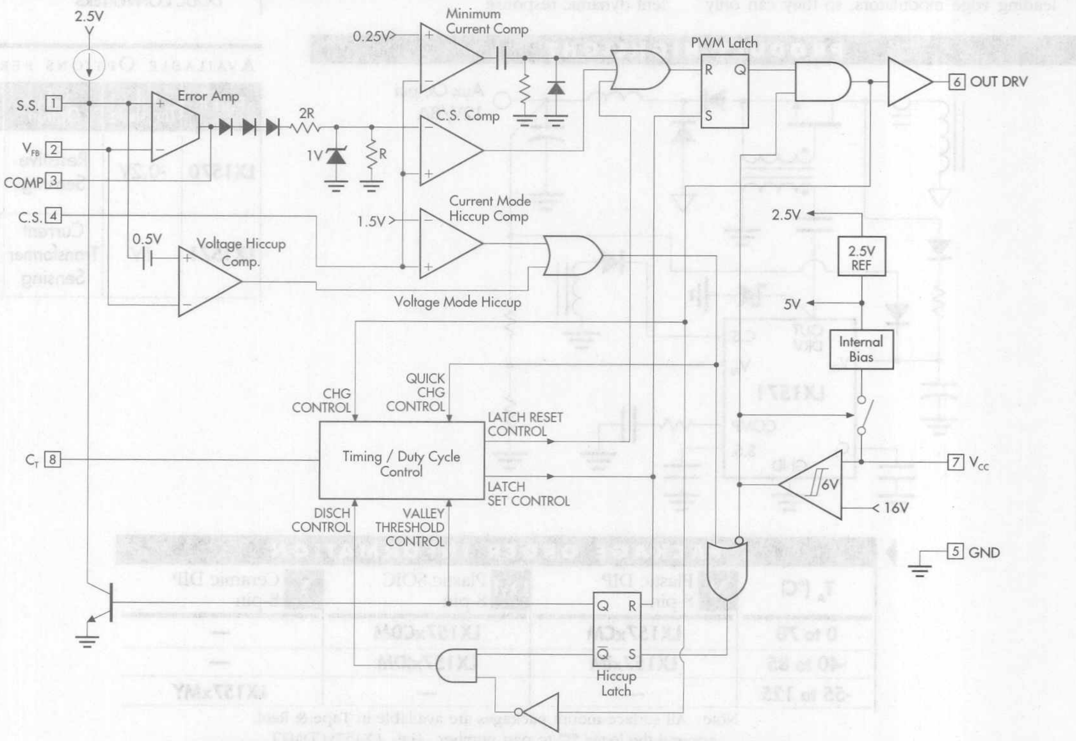
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Y PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

LX1571 BLOCK DIAGRAM



PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

PRELIMINARY DATA SHEET

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the ranges T_A = -55 to 125°C for the LX1570M/1571M, T_A = -40 to 85°C for the LX1570I/1571I, and T_A = 0 to 70°C for LX1570C/1571C. V_{CC} = 15V. Typ. number represents T_A = 25°C value.)

Parameter		Symbol	Test Conditions	LX1570/1571 Min.	Typ.	Max.	Units
Reference Section							
Initial Accuracy		V_{RI}	T_A = 25°C, measured at F.B pin	2.475	2.500	2.525	V
Line Regulation		ΔV_{RL}	11V < V_{CC} < 25			±1	%
Temp Stability		ΔV_{RT}	Note 2			±1.5	%
Timing Section							
Initial Accuracy		f_O	C_T = , T_J = 25°C, measured at pin 6	90	100	110	kHz
			Over Temp, measured at pin 6	85	100	115	kHz
Line Voltage Stability		Δf_{OL}				±1	%
Charging Current		I_{CHG}			3		mA
Discharging Current		I_{DISCH}			3.5		mA
Leakage Current		I_{LK}	$C.S._{INPUT}$ = 1.5V		4		μA
Ramp PK to PK		V_{RPP}	$C.S._{INPUT}$ = 0V		0.6		V
			$C.S._{INPUT}$ = 1.5V (1571), $C.S._{INPUT}$ = -0.4V (1570)		6		V
Error Amp / Soft Start Comp Section							
Transconductance		g_m			0.005		μΩ
Input Bias Current		I_B			0.1	1	μA
Open Loop Gain		A_{VOL}		60	70		dB
Output Sink Current		$I_{EA(SINK)}$	V_{FB} = 2.6V	200	400		μA
Output Source Current		$I_{EA(SOURCE)}$	V_{FB} = 2.4V	200	400		μA
Output HI Voltage		$V_{COMP-HI}$			5.1		V
Output LO Voltage		$V_{COMP-LO}$				0.8	V
Slew Rate		S			1		V/μSec
Soft-Start Section							
Soft Start Timing Factor		K_{SS}		35	50	65	ms/μF
Soft Start Discharge Current		I_{SS-DIS}			TBD		mA
Current Sense Section							
Input Range	LX1570	V_{CSI}				-0.8	V
	LX1571			-0.3		6	V
Input Current	LX1570	I_{CSB}				25	μA
	LX1571					1	μA
C.S. Amplifier Gain	LX1570	A_{CS}		-13.5	-15	-16.5	V/V
	LX1571			2.7	3	3.3	V/V
Minimum Current Threshold Voltage	LX1570	V_{CSMIN}			-50		mV
	LX1571				250		mV
C.S. Delay to Driver Output			10% Overdrive		100	200	ns
C.L. Pulse-By-Pulse Threshold Voltage	LX1570	V_{CLP}		-0.18	-0.2	-0.22	V
	LX1571			0.9	1	1.1	V
C.L. Hiccup Threshold Voltage	LX1570	V_{CLH}			-0.3		V
	LX1571				1.5		V
Voltage Hiccup Threshold		V_{HCCP}			2		V

Note 2. Although this parameter is guaranteed, it is not 100% tested in production.

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PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

PRELIMINARY DATA SHEET

ELECTRICAL CHARACTERISTICS (Con't.)

Parameter	Symbol	Test Conditions	LX1570/1571 Min.	LX1570/1571 Typ.	LX1570/1571 Max.	Units
PWM Section						
E.A. Output to PWM Drive Offset	V_{OFS}		1.7	2.0	2.4	V
Fixed Duty Cycle	D		52	54	56	%
Output Drive Section						
Rise / Fall Time	t_R / t_F	C_L = 1000pF		50		ns
Output HI	V_{DH}	I_{SOURCE} = 200mA, V_{CS} = 0V, V_{FB} = 2.3V		13.5		V
Output LO	V_{DL}	I_{SINK} = 200mA, V_{CS} = 1.2V, V_{FB} = 2.3V		0.8		V
Output Pull Down	V_{DPD}	V_{CC} = 0V, $I_{PULL\ UP}$ = 2mA		1		V
UVLO Section						
Start-Up Threshold	V_{ST}		15	16	17	V
Turn Off Threshold	V_{OFF}		9	10	11	V
Hysterises	V_H		5.5	6	6.5	V
Supply Current Section						
Dynamic Operating Current	I_{Qd}	Out Freq = 100kHz, C_L = 0		18	30	mA
Start-Up Current	I_{ST}			150	250	μA

FUNCTIONAL PIN DESCRIPTION

Pin	#	Description
S.S.	1	This pin acts as the soft-start pin. A capacitor connected from this pin to GND allows slow ramp up of the NI input resulting in output soft start during start up. This pin is clamped to the internal voltage reference during the normal operation and sets the reference for the feedback regulator.
V_{FB}	2	This pin is the inverting input of the Error Amplifier. It is normally connected to the switching power supply output through a resistor divider to program the power supply voltage. This pin instead of the NI pin is internally trimed to 1% tolerance to include the offset voltage error of the error amp.
COMP	3	This pin is the Error Amplifier output and is made available for loop compensation. Typically a series R&C network is connected from this pin to GND.
C.S.	4	A voltage proportional to the inductor current is sensed by an external sense resistor (1570) or current transformer (1571) in series with the return line and is connected to this pin. The output drive is terminated and latched off when this voltage amplified by the internal gain (see option table) exceeds the voltage set by the E.A output voltage. The maximum allowable voltage at this pin during normal operation is -0.8V typ for LX1570 and 6V typ for LX1571.
GND	5	This pin is combined control circuitry and power GND. All other pins must be positive with respect to this pin, except for C.S pin.
OUT DRV	6	This pin drives a gate drive transformer which drives the power mosfet. A Schottky diode such as 1N5817 must be connected from this pin to GND in order to prevent the substrate diode conduction.
V_{CC}	7	This pin is the positive supply voltage for the control IC. A high frequency capacitor must be closely placed and connected from this pin to GND to provide the turn-on and turn-off peak currents required for fast switching of the power Mosfet.
C_T	8	The free running oscillator frequency is programmed by connecting a capacitor from this pin to GND.

APPLICATION INFORMATION

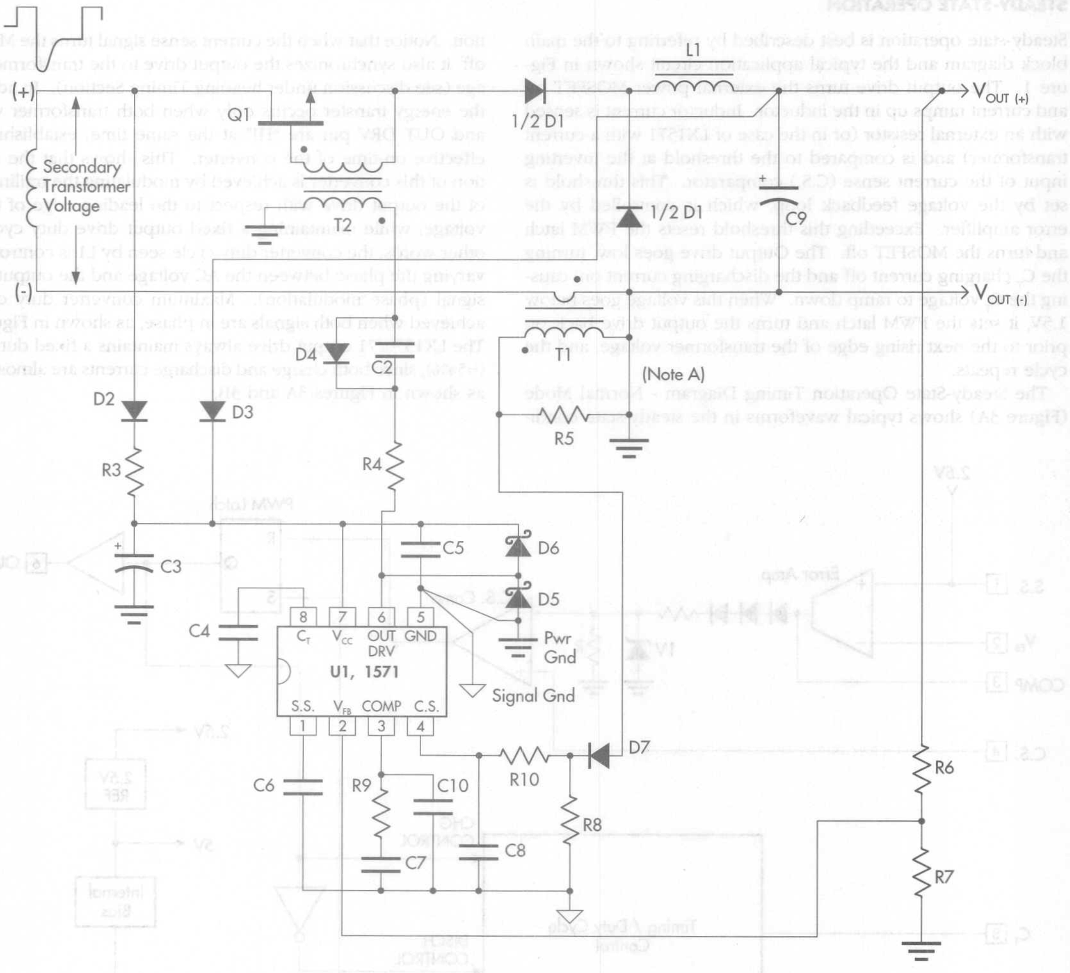

FIGURE 1 — THE LX1571 IN A TYPICAL SECONDARY-SIDE POWER SUPPLY APPLICATION

IC DESCRIPTION

STEADY-STATE OPERATION

Steady-state operation is best described by referring to the main block diagram and the typical application circuit shown in Figure 1. The output drive turns the external power MOSFET on and current ramps up in the inductor. Inductor current is sensed with an external resistor (or in the case of LX1571 with a current transformer) and is compared to the threshold at the inverting input of the current sense (C.S.) comparator. This threshold is set by the voltage feedback loop, which is controlled by the error amplifier. Exceeding this threshold resets the PWM latch and turns the MOSFET off. The Output drive goes low, turning the C_T charging current off and the discharging current on, causing the C_T voltage to ramp down. When this voltage goes below 1.5V, it sets the PWM latch and turns the output drive back on prior to the next rising edge of the transformer voltage, and the cycle repeats.

The Steady-State Operation Timing Diagram - Normal Mode (Figure 3A) shows typical waveforms in the steady-state condition. Notice that when the current sense signal turns the MOSFET off, it also synchronizes the output drive to the transformer voltage (see discussion under heading Timing Section). In addition, the energy transfer occurs only when both transformer voltage and OUT DRV pin are "HI" at the same time, establishing the effective on-time of the converter. This shows that the regulation of this converter is achieved by modulating the trailing edge of the output drive with respect to the leading edge of the AC voltage, while maintaining a fixed output drive duty cycle. In other words, the converter duty cycle seen by L1 is controlled by varying the phase between the AC voltage and the output driver signal (phase modulation). Maximum converter duty cycle is achieved when both signals are in phase, as shown in Figure 3B. The LX1570/71 output drive always maintains a fixed duty cycle (≈54%), since both charge and discharge currents are almost equal as shown in Figures 3A and 3B.

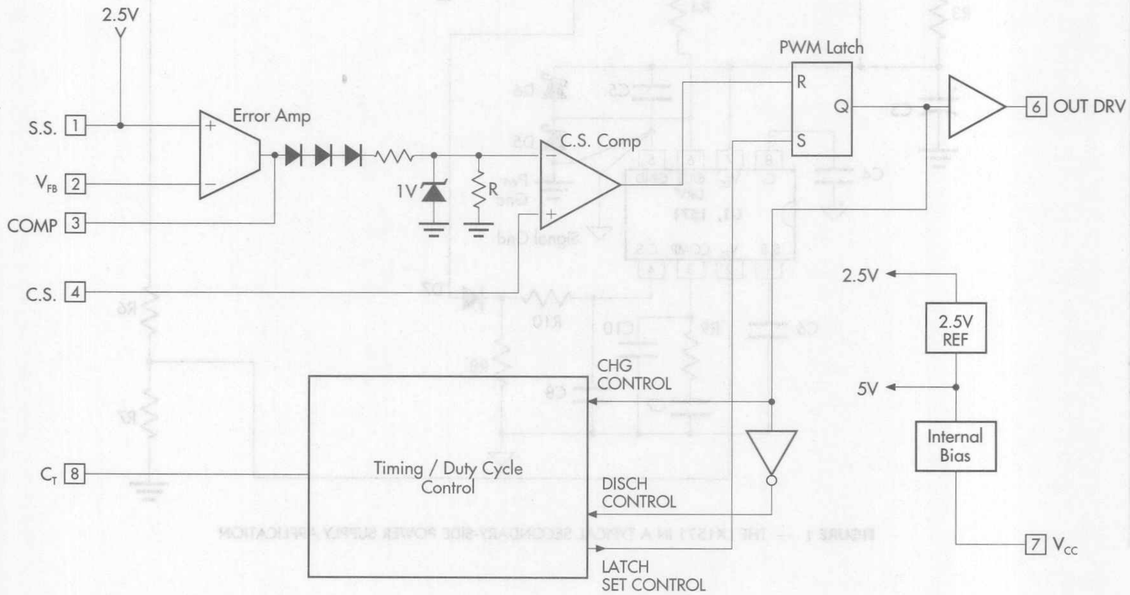

FIGURE 2 — STEADY-STATE OPERATION BLOCK DIAGRAM

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IC DESCRIPTION

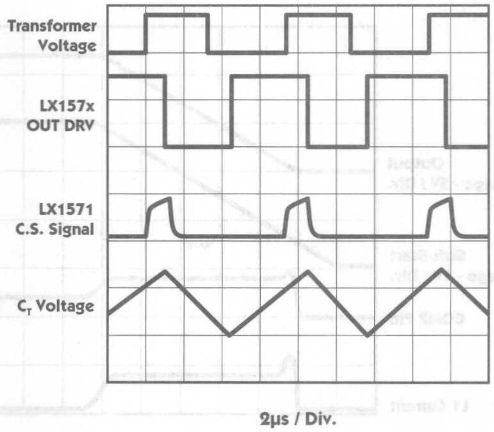


FIGURE 3A — STEADY-STATE OPERATION TIMING DIAGRAM (NORMAL MODE)

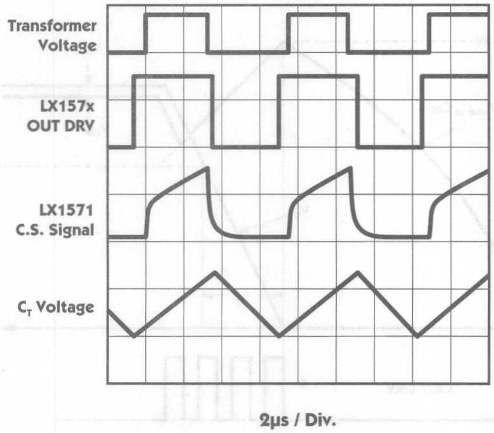


FIGURE 3B — STEADY-STATE OPERATION TIMING DIAGRAM (MAXIMUM DUTY CYCLE)

START-UP OPERATION

Using the main Block Diagram and the LX157x V_{CC} Start-Up Voltage Timing Diagram (Figure 4) as a reference, when the V_{CC} voltage passes the UVLO threshold (16V typ.), the output of the UVLO comparator changes to the "HI" state, which causes the following: *a)* provides biasing for internal circuitry, and *b)* enables the output drive and the HICCUP latch. This signal sets the "Q" output of the HICCUP latch "LO", allowing the soft-start (S.S.) capacitor voltage to ramp up, forcing the regulator output to follow this voltage. Since the IC provides a constant current source for charging the S.S. capacitor, the resulting waveform is a smooth linear ramp, which provides lower in-rush current during start up.

The Start-Up Timing Diagram (Figure 5) shows the output voltage and the S.S. capacitor during start up. Notice that the output voltage does not respond to the S.S. capacitor until this voltage goes above ≈0.65 volts, allowing this pin to be used as an external shutdown pin. The value of the soft start capacitor must be selected such that its ramp up time (t_{RAMP}) is always greater than the start up time of the converter, so that the converter is able to follow the soft-start capacitor.

It is recommended that the soft start capacitor is always selected such that its ramp up time (t_{RAMP}) be at least 4 times greater than the converter's minimum start-up time. Equations 1 and 2 show how to select this capacitor.

$$t_{RAMP} = 4 * \frac{C_O * V_O}{I_O} \qquad \text{Equation 1}$$

Once t_{RAMP} is known, the soft-start capacitor can then be calculated as follows:

$$C_{SS} = \frac{t_{RAMP}}{35} \qquad \text{Equation 2}$$

where C_{SS} is in µF and t_{RAMP} is in ms.

Example: If C_O = 1600µF, V_O = 12V, I_O = 4A

$$t_{RAMP} = 4 * \frac{1600 * 10^{-6} * 12}{4} = 19.2\text{ms}$$

$$C_{SS} = \frac{19.2}{35} = 0.55\mu\text{F}$$

The LX1570/71 series also features micropower start-up current that allows these controllers to be powered off the transformer voltage via a low-power resistor and a start-up capacitor. After the IC starts operating, the output of the converter can be used to power the IC. In applications where the output is less than the minimum operating voltage of the IC, an extra winding on the inductor can be used to perform the same function. The start-up capacitor must also be selected so that it can supply the power to the IC long enough for the output of the converter to ramp up beyond the start-up threshold of the IC. Equation 3 shows how to select the start-up capacitor.

$$C_{ST} = 2\left(\frac{I_Q * t_{ST}}{V_H}\right) \qquad \text{Equation 3}$$

where: I_Q ≡ Dynamic operating current of the IC
t_{ST} ≡ Time for the bootstrap voltage to go above the minimum operating voltage (10V typ.)
V_{HYST} ≡ Minimum hysteresis voltage of the IC

Example: If I_Q = 30mA, t_{ST} = 19ms, V_{HYST} = 5.5V

$$C_{ST} = 2\left(\frac{30 * 10^{-3} * 19 * 10^{-3}}{5.5}\right) = 207\mu\text{F}$$

IC DESCRIPTION

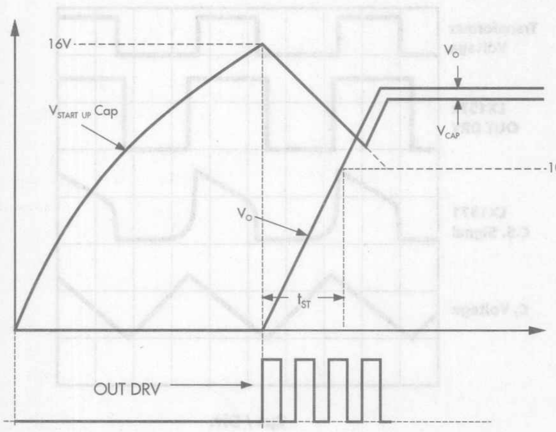


FIGURE 4 — LX157x V_{CC} START-UP VOLTAGE TIMING DIAGRAM

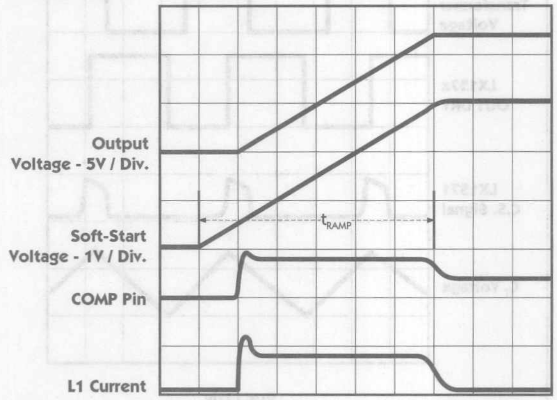


FIGURE 5 — START-UP TIMING DIAGRAM

TIMING SECTION

A capacitor connected from the C_T pin to ground performs several functions. First, it sets the OUT DRV duty cycle to a constant 54% (regardless of the C_T value) in order to: *a)* provide the gate drive for an N-channel MOSFET, utilizing a simple gate drive transformer, and *b)* insure reliable operation with a transformer duty cycle within a 0 to 50% range. Second, it sets the free-running frequency of the converter in order to insure the continuous operation during non-steady state conditions, such as start up, load transient and current limiting operations. The value of the timing capacitor is selected so that the free-running frequency is always 20% below the minimum operating frequency of the secondary transformer voltage, insuring proper operation.

Equation 4 shows how to select the timing capacitor C_T.

$$C_T = \frac{1}{V_{RPP} * f_S * \left[\frac{1}{I_{CHG}} + \frac{1}{I_{DISCH}}\right]} \quad \text{Equation 4}$$

where: V_{RPP} ≡ Peak to peak voltage of C_T (0.6V typ.)
f_S ≡ Free-running frequency of the converter. Selected to be 80% of the minimum freq. of the seconday side transformer voltage.
I_{CHG} ≡ C_T charging current (3mA typ.)
I_{DISCH} ≡ C_T discharge current (3.5mA typ.)

Example: Assuming the transformer frequency is at 100kHz, $V_{RPP} = 0.6V$, $I_{CHG} = 3mA$, $I_{DISCH} = 3.5mA$.

$$C_T = \frac{1}{0.6 * 80 * 10^3 * \left[\frac{1}{3 * 10^{-3}} + \frac{1}{3.5 * 10^{-3}}\right]} = 0.033\mu F$$

CURRENT LIMITING

Using the main Block Diagram as a reference and the typical application circuit of Figure 1, note that current limiting is performed by sensing the current in the return line using a current transformer in series with the switch. The voltage at C.S. pin is then amplified and compared with an internal threshold. Exceeding this threshold turns the output drive off and latches it off until the set input of the PWM latch goes high again. However, if the current keeps rising such that it exceeds the HICCUP comparator threshold, or if the output of the converter drops by ≈20% from its regulated point, two things will happen. First, the HICCUP comparator pulls C_T pin to 6V, which keeps the output drive off and causes C_T charging current to be disconnected. Second, it sets the HICCUP latch, causing the discharge current to be turned off until the C_T capacitor voltage goes below 0.3V. Since both charge and discharge currents are disconnected from the capacitor, the only discharge path for C_T is the internal 2µA current source. When this happens, a very slow discharge occurs, resulting in a long delay time between current limit cycles which greatly reduces power MOSFET dissipation under short circuit conditions.

Look-ahead Switching™ is a trademark of Linfinity Microelectronics Inc.

LINFINITY MICROELECTRONICS

IC DESCRIPTION

MINIMUM CURRENT COMPARATOR

One of the main advantages of replacing a Magnetic Amplifier with a MOSFET, is the MOSFET's ability to respond quickly to large changes in load requirements. Because the LX1570/71 relies on the C.S. signal for synchronization, special circuitry had to be added to keep the output drive synchronized to the transformer voltage during such load transient conditions. This condition is best explained by referring to Figure 6. In Figure 6, it can be seen that the load current is stepped from 0.4A to 4A, causing the COMP pin to slew faster than the inductor current, starting with the second switching cycle after the load transient has occured. This condition eliminates the normal means of resetting the PWM latch through the C.S. comparator path. To compensate for this condition, a second comparator is ORed with the C.S. comparator, which resets the latch on the falling edge of the C.S. signal caused by the falling edge of the transformer voltage.

In other words, the function of the minimum C.S. comparator is to turn OUT DRV off on the falling edge of the C.S. signal, if it is not already off. This assures that the output drive is on before the start of the next AC input cycle (Look-Ahead Switching™), allowing maximum converter duty cycle.

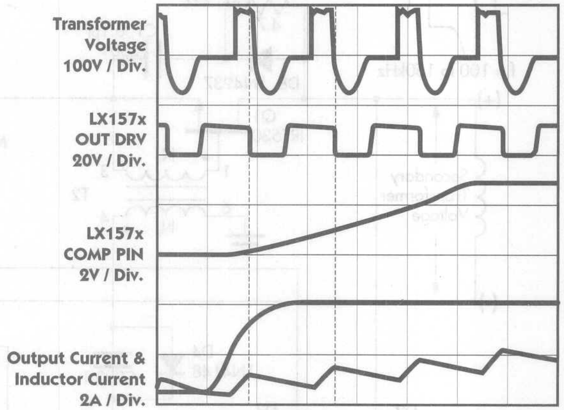


FIGURE 6 — MINIMUM CURRENT COMPARATOR EFFECT DURING LOAD TRANSIENT

ERROR AMPLIFIER

The function of the error amplifier is to set a threshold voltage for inductor peak current and to control the converter duty cycle, such that power supply output voltage is closely regulated. Regulation is done by sensing the output voltage and comparing it to the internal 2.5V reference. A compensation network based on the application is placed from the output of the amplifier to GND for closed loop stability purposes as well as providing high DC gain for tight regulation. The function of "$3V_{BE}$" offset is to keep output drive off without requiring the error amplifier output to swing to ground level. The transfer function between error amp output (V_{COMP}) and peak inductor current is therefore given by:

$$V_{COMP} - 3V_{BE} = I_P * G$$

where:
I_P = inductor peak current,
G = resistor divider gain, (-15 for LX1570, 3 for LX1571)
V_{BE} = diode forward voltage (0.65V typ)

12V/8V SCHEMATIC

Note: Linfinity provides a complete and tested evaluation board. For further information contact factory.

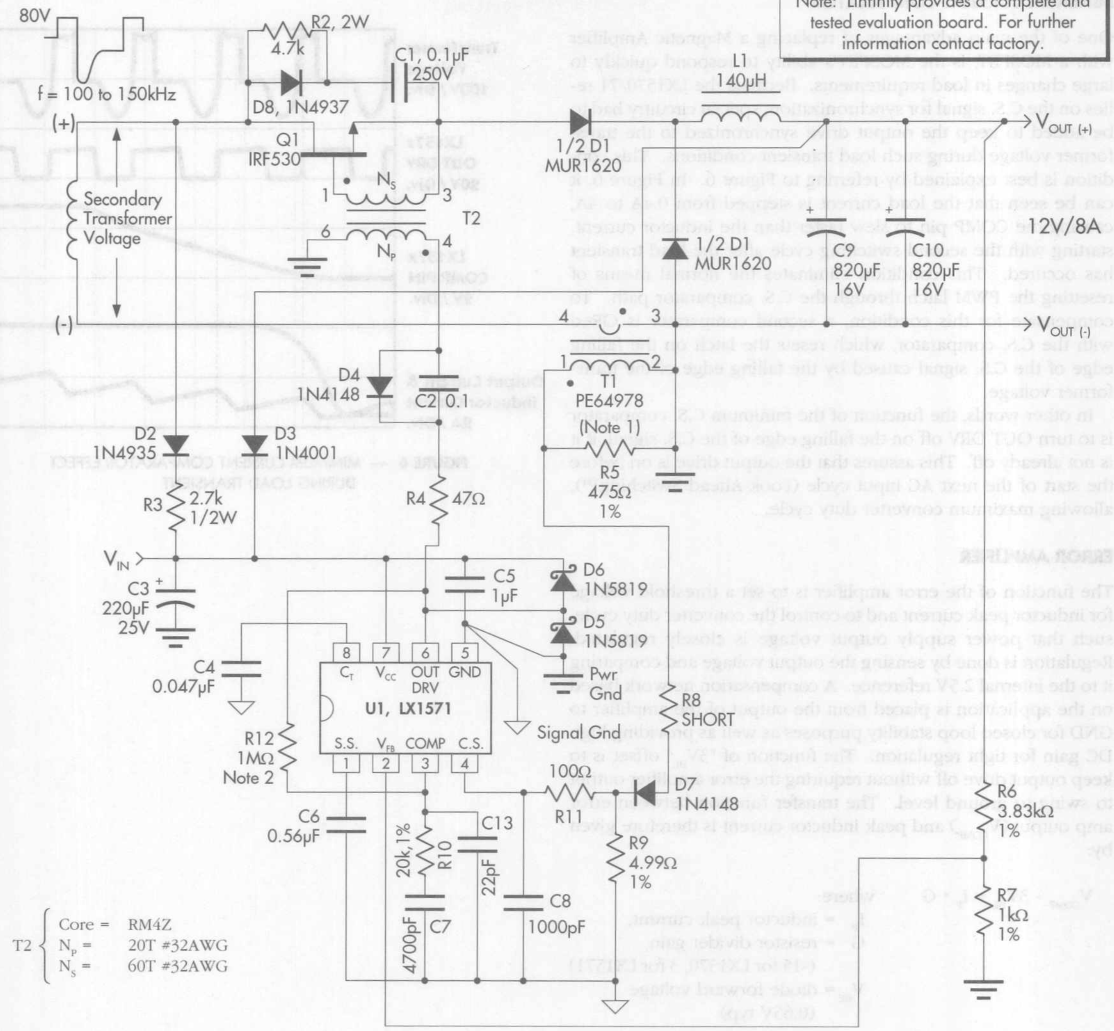


FIGURE 7 — THE LX1571 IN A 12V/8A SECONDARY-SIDE POWER SUPPLY APPLICATION

Unless otherwise noted all resistors are 1/4W, 5%.
Note 1: For further information on PE64978 contact Pulse Engineering at 619-674-8100.
Note 2: A high value resistor must be coupled back to "COMP" pin to insure proper operation under light load conditions.

LINFINITY MICROELECTRONICS

3.3V/10V SCHEMATIC

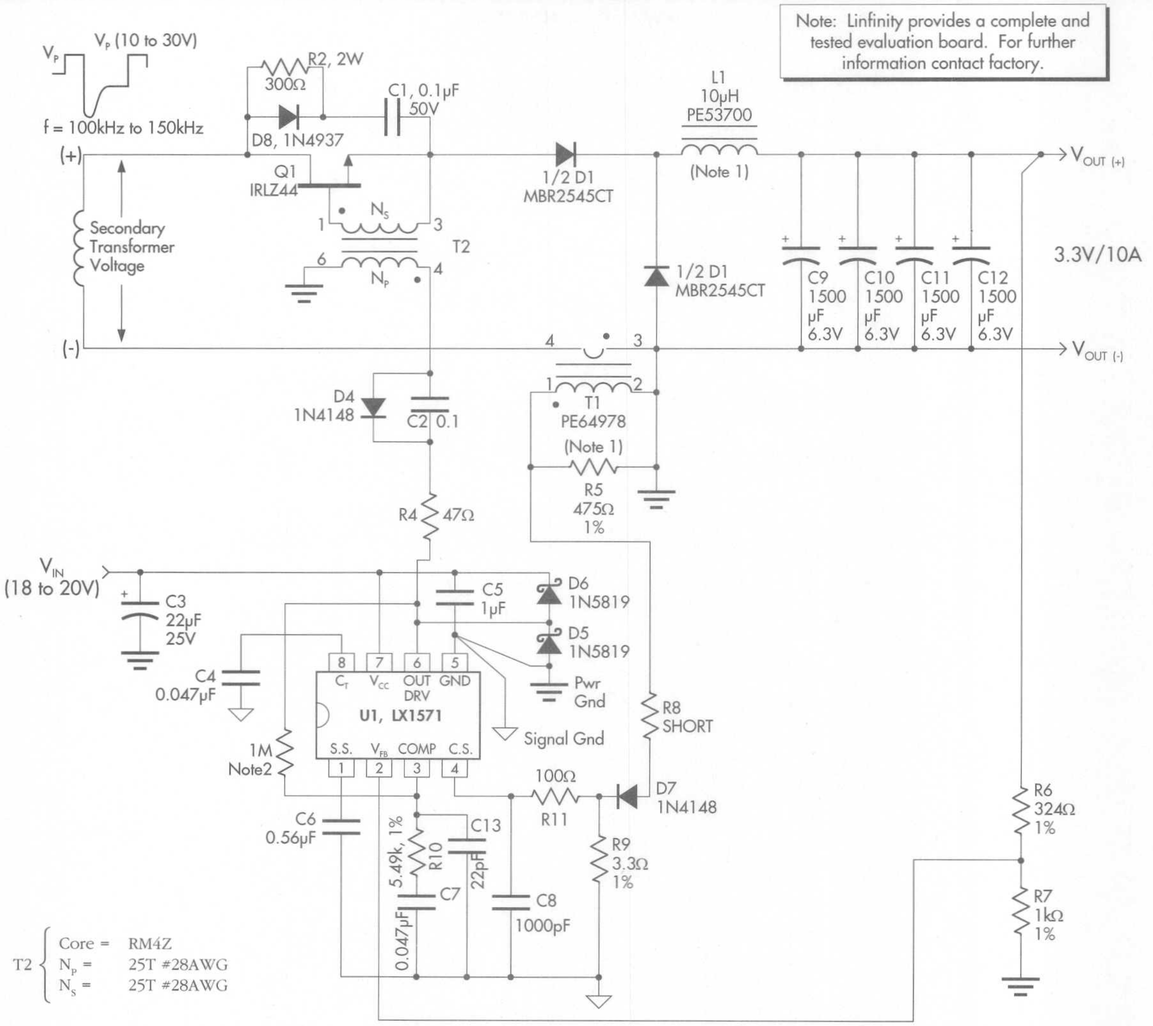


FIGURE 7 — THE LX1571 IN A 3.3V/10A SECONDARY-SIDE POWER SUPPLY APPLICATION

Unless otherwise noted all resistors are 1/4W, 5%.
Note 1: For further information on PE53700 and PE64978 contact Pulse Engineering at 619-674-8100.
Note 2: A high value resistor must be coupled back to "COMP" pin to insure proper operation under light load conditions.

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX1823

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

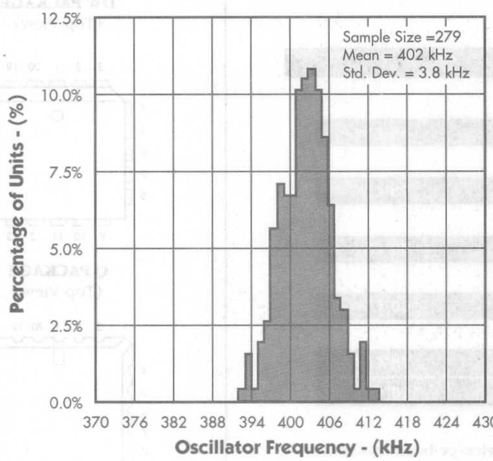
The LX1823 is a high-performance pulse width modulator optimized for high frequency current-mode power supplies. Included in the controller are a precision voltage reference, micropower start-up circuitry, soft-start, high-frequency oscillator, wideband error amplifier, fast current-limit comparator, full double-pulse suppression logic, and a single totem-pole output driver. Innovative circuit design and an advanced linear Schottky process result in very short propagation delays through the current limit comparator, logic, and the output driver. This device can be used to implement either current-mode or voltage-mode switching power supplies. The LX1823 is an ideal choice for applications such as single ended boost converters. The LX1823C is selected for the commercial range of 0°C to 70°C, the LX1823I is characterized for the industrial range of -25°C to 85°C, and the LX1823M is specified for operation over the full military ambient temperature range of -55°C to 125°C.

KEY FEATURES

- **IMPROVED OSCILLATOR INITIAL ACCURACY** (±2% typ.)
- **IMPROVED STARTUP CURRENT** (460µA typ.)
- **PROP DELAY TO OUTPUTS** (80ns max.)
- 10V TO 30V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 1.5MHz OSCILLATOR CAPABILITY
- 1.5A PEAK TOTEM-POLE DRIVERS
- U.V. LOCKOUT WITH HYSTERESIS
- NO OUTPUT DRIVER "FLOAT"
- PROGRAMMABLE SOFT START
- DOUBLE-PULSE SUPPRESSION LOGIC
- WIDEBAND LOW-IMPEDANCE ERROR AMPLIFIER
- CURRENT-MODE OR VOLTAGE-MODE CONTROL
- WIDE CHOICE OF PACKAGES

PRODUCT HIGHLIGHT

INITIAL OSCILLATOR ACCURACY



APPLICATIONS

- HIGH FREQUENCY DC/DC BUCK, BOOST, & FORWARD CONVERTERS
- SERVO MOTOR CONTROL

HI-REL FEATURES

- AVAILABLE TO MIL-STD-883B
- Linfinity LEVEL "S" PROCESSING AVALABLE

PACKAGE ORDER INFORMATION

T_J (°C)	N Plastic DIP 16-pin	DW Plastic Wide SOIC 16-pin	Q Plastic LCC 20-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin
0 to 70	LX1823CN	LX1823CDW	LX1823CQ	—	—
-25 to 85	LX1823IN	LX1823IDW	LX1823IQ	LX1823IJ	—
-55 to 125	—	—	—	LX1823MJ	LX1823ML

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1823CDWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage (V_{IN} and V_C) 30V
Analog Inputs:
  Error Amplifier and Ramp .... -0.3V to 7.0V
  Softstart and I_{LIM}/S.D. .... -0.3V to 6.0V
Digital Input (Clock) .... 1.5V to 6.0V
Driver Outputs .... -0.3V to V_C+1.5V
Source / Sink Output Current (each output):
  Continuous 0.5A
  Pulse, 500ns 2.0A
Softstart Sink Current 20mA
Clock Output Current 5mA
Error Amplifier Output Current 5mA
Oscillator Charging Current 5mA
Operating Junction Temperature:
  Hermetic (J, L Package) .... 150°C
  Plastic (DW, N, Q Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device.

THERMAL DATA

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

DW PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

Q PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

J PACKAGE:

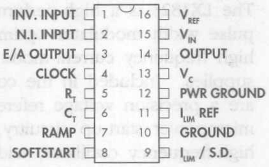
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

L PACKAGE:

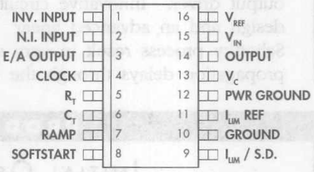
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

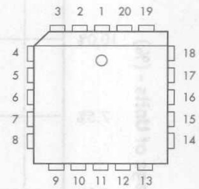
PACKAGE PIN OUTS



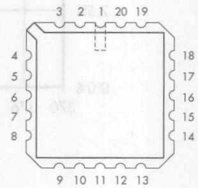
J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



Q PACKAGE
(Top View)



L PACKAGE
(Top View)

1. N.C.	11. N.C.
2. INV. INPUT	12. I_{LIM} / S.D.
3. N.I. INPUT	13. GROUND
4. E/A OUTPUT	14. I_{LIM} REF
5. CLOCK	15. PWR GND
6. N.C.	16. N.C.
7. R_T	17. V_C
8. C_T	18. OUTPUT
9. RAMP	19. V_{IN}
10. SOFTSTART	20. V_{REF}

LINFINITY MICROELECTRONICS

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
Supply Voltage Range	V_{IN}, V_C	10		30	V
Voltage Amp Common Mode Range		1.5		5.5	V
Ramp Input Voltage Range		0		5.0	V
Current Limit / Shutdown Voltage Range		0		4.0	V
Source / Sink Output Current					
Continuous			200		mA
Pulse, 500ns			1.5		A
Voltage Reference Output Current				10	mA
Oscillator Frequency Range		4		1500	kHz
Oscillator Charging Current		0.030		3	mA
Oscillator Timing Resistor	R_T	1		100	kΩ
Oscillator Timing Capacitor	C_T	0.470		10	nF
Operating Ambient Temperature Range:					
LX1823C	T_A	0		70	°C
LX1823I	T_A	-25		85	°C
LX1823M	T_A	-55		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX1823C with 0°C ≤ T_A ≤ 70°C, LX1823I with -25°C ≤ T_A ≤ 85°C, LX1823M with -55°C ≤ T_A ≤ 125°C, and V_{IN}=V_C=15V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX1823C/1823I/1823M			Units
			Min.	Typ.	Max.	
Reference Section						
Output Voltage	V_{REF}	T_J = 25°C, I_L = 1mA	5.05	5.10	5.15	V
Line Regulation		V_{IN} = 10 to 30V		0.2	5	mV
Load Regulation		I_L = 1 to 10mA		3	15	mV
Temperature Stability (Note 4)		Over Operating Temperature			0.4	mV/°C
Total Output Range (Note 4)		Over Line, Load, and Temperature	5.00		5.20	V
Output Noise Voltage (Note 4)		f = 10Hz to 10kHz		50		μV_{RMS}
Long Term Stability (Notes 4 & 5)		T_J = 125°C, t = 1000hrs		5	25	mV
Short Circuit Current		V_{REF} = 0V	-15	-50	-100	mA
Oscillator Section (Note 6)						
Initial Accuracy		T_J = 25°C, C_{CLOCK} ≤ 10pF	370	400	430	kHz
Voltage Stability		V_{IN} = 10 to 30V		0.4	2	%
Temperature Stability (Note 4)		Over Rated Operating Temperature		5	8	%
Total Frequency Limits (Note 4)		Over Line and Temperature	350		450	kHz
Minimum Frequency		R_T = 100KΩ, C_T = 0.01µF			4	kHz
Maximum Frequency		R_T = 1KΩ, C_T = 470pF	1.5			MHz
Clock High Level		I_{CLK} = -1mA	3.9	4.3		V
Clock Low Level		I_{CLK} = -1mA		2.3	2.9	V
Ramp Peak Voltage				2.7		V
Ramp Valley Voltage				1.0		V
Valley-to-Peak Amplitude				1.7		V

Note 3. Low duty cycle pulse testing techniques are used which maintains junction and case temperature equal to the ambient temperature.
Note 4. This parameter is guaranteed by design and process control, but is not 100% tested in production.
Note 5. This parameter is non-accumulative, and represents the random fluctuation of the reference voltage within some error band when observed over any 1000 hour period of time.

NOT RECOMMENDED FOR NEW DESIGNS

ELECTRICAL CHARACTERISTICS (Continued — Note 3)

Parameter	Symbol	Test Conditions	LX1823C/1823I/1823M Min.	Typ.	Max.	Units
Error Amplifier Section (Note 7)						
Input Offset Voltage		$R_S \leq 2K\Omega$, E/A OUTPUT = 2.5V			20	mV
Input Bias Current		E/A OUTPUT = 2.5V		0.4	3	µA
Input Offset Current		E/A OUTPUT = 2.5V			1	µA
DC Open Loop Gain	A_{VOL}	E/A OUTPUT = 1 to 4V	60	100		dB
Common Mode Rejection		Over Rated Voltage Range, E/A OUTPUT = 2.5V	75	110		dB
Power Supply Rejection		V_{IN} = 10V to 30V, E/A OUTPUT = 2.5V	85	100		dB
Output Sink Current		E/A OUTPUT = 1V	1			mA
Output Source Current		E/A OUTPUT = 4V	-0.5	-1.3		mA
Output High Voltage		E/A OUTPUT = -0.5mA	4.0	4.85	5.0	V
Output Low Voltage		E/A OUTPUT = 1mA	0	0.6	1.0	V
Unity Gain Bandwidth (Note 4)		A_{VOL} = 0dB	3	5.5		MHz
Slew Rate (Note 4)			6	12		V/µsec
PWM Comparator Section (Note 6 & 8)						
Ramp Input Bias Current				-1	-5	µA
Minimum Duty Cycle		E/A OUTPUT = 1V			0	%
Maximum Duty Cycle (Note 9)		LX1823C/LX1823I, E/A OUTPUT = 4V	85			%
		LX1823M, E/A OUTPUT = 4V	80			%
Zero Duty Cycle Threshold			1.1	1.3		V
Delay to Driver Output (Note 4)		RAMP = 0V to 2V, E/A OUTPUT = 2V			80	ns
Softstart Section						
Charge Current		SOFTSTART = 0.5V	3	7	20	µA
Discharge Current		SOFTSTART = 1.0V	1			mA
Current Limit / Shutdown Section (Note 10)						
I_{LIM}/S.D. Input Bias Current		LX1823C only			±10	µA
		LX1823M/LX1823I only			±15	µA
I_{LIM} REF Offset		I_{LIM} REF = 1.1V			15	mV
I_{LIM} REF Common Mode Range			1.0		1.25	V
Shutdown Threshold			1.25	1.40	1.55	V
Delay to Driver Output (Note 4)		I_{LIM} / S.D. = 0V to 2V			80	ns
Output Drivers Section (each output)						
Output Low Level		I_{SINK} = 20mA		0.21	0.40	V
		I_{SINK} = 200mA		1.2	2.2	V
Output High Level		I_{SOURCE} = 20mA	13.0	13.5		V
		I_{SOURCE} = 200mA	12.0	13.0		V
V_C Standby Current		$V_{IN} = V_C$ = 30V		180	500	µA
Output Rise / Fall Time (Note 4)		C_L = 1000pF		30	60	ns
Undervoltage Lockout Section						
Start Threshold Voltage			8.80	9.35	9.80	V
UV Lockout Hysteresis			0.4	0.8	1.2	V
Supply Current Section (Note 6)						
Start Up Current		V_{IN} = 8V		460	1000	µA
Operating Current		INV. INPUT, RAMP, (I_{LIM}/S.D.) = 0V, N.I. INPUT = 1V		24	33	mA

Note 6. f_{OSC} = 400kHz (R_T = 3.65kΩ, C_T = 1.0nF).
Note 7. V_{CM} = 1.5V to 5.5V.
Note 8. V_{RAMP} = 0V, unless otherwise specified.
Note 9. 100% duty cycle is defined as a pulsewidth equal to one oscillator period.
Note 10. V(I_{LIM}/S.D.) = 0V to 4.0V, unless otherwise specified.

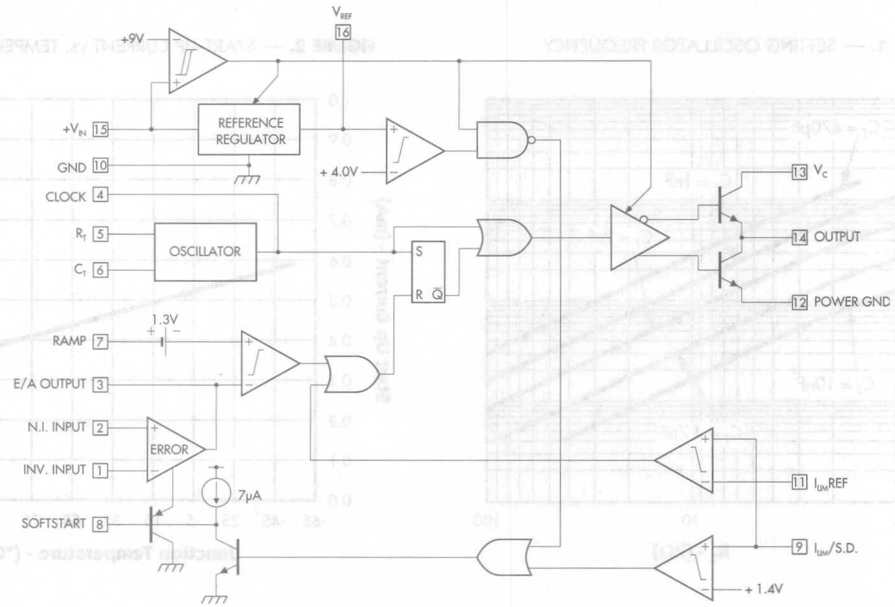
LINFINITY MICROELECTRONICS

LX1823

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

BLOCK DIAGRAM



GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

FIGURE INDEX

Application Circuits

FIGURE #

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — SETTING OSCILLATOR FREQUENCY

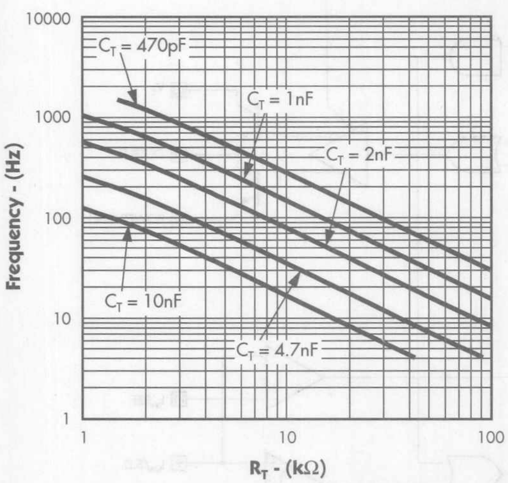


FIGURE 2. — START-UP CURRENT vs. TEMPERATURE

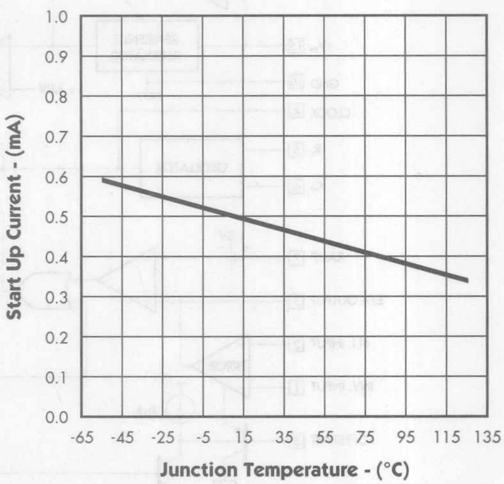


FIGURE 3. — OUTPUT DRIVER HIGH vs. I_{SOURCE}

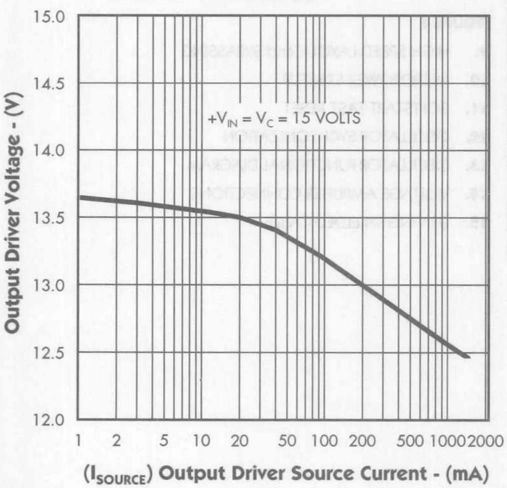
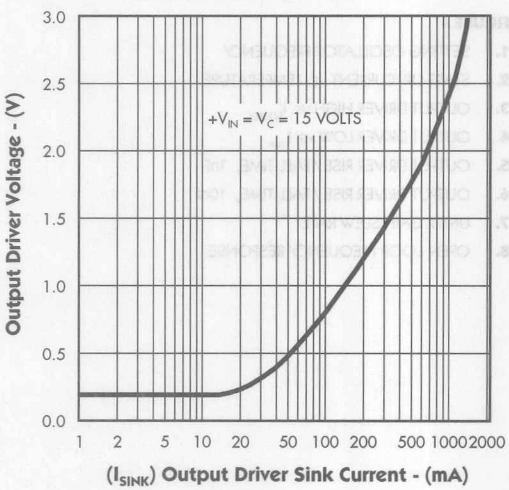


FIGURE 4. — OUTPUT DRIVER LOW vs. I_{SINK}



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — OUTPUT DRIVE RISE / FALL TIME, 1nF

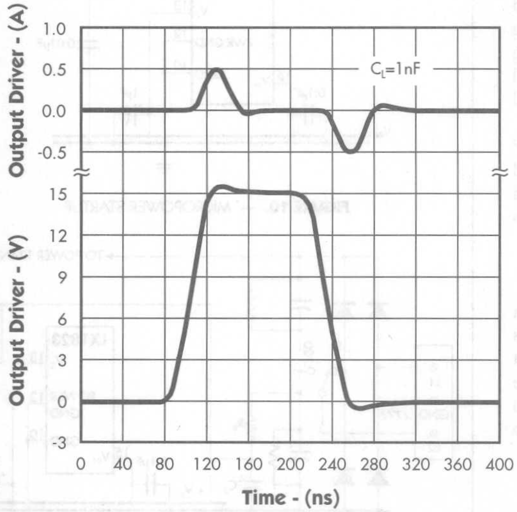


FIGURE 6. — OUTPUT DRIVER RISE / FALL TIME, 10nF

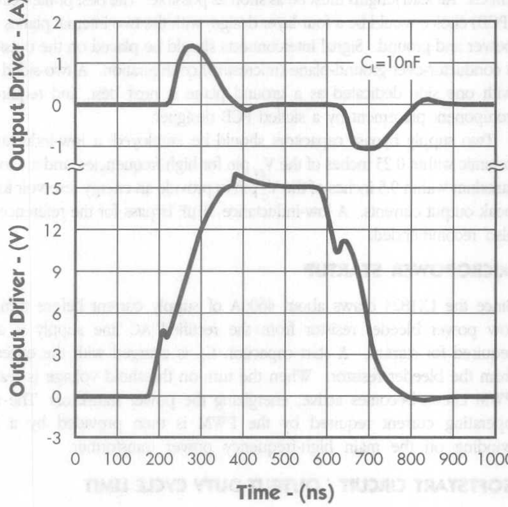


FIGURE 7. — UNITY GAIN SLEW RATE

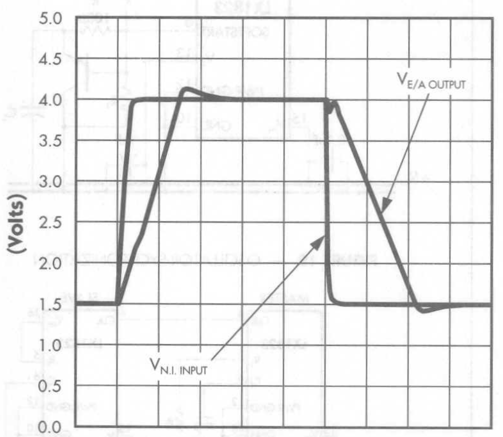
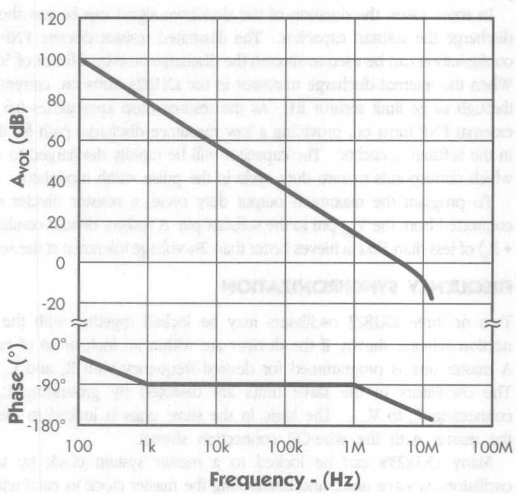


FIGURE 8. — OPEN LOOP FREQUENCY RESPONSE



APPLICATION INFORMATION

HIGH-SPEED LAYOUT AND BYPASSING

The LX1823, like all high-speed circuits, requires extra attention to external conductor and component layout to minimize undesired inductive and capacitive effects. All lead lengths must be as short as possible. The best printed circuit board (PCB) choice would be a four-layer design, with the two internal planes supplying power and ground. Signal interconnects should be placed on the outside, giving a conductor-over-ground-plane (microstrip) configuration. A two-sided PC board with one side dedicated as a ground plane is next best, and requires careful component placement by a skilled PCB designer.

Two supply bypass capacitors should be employed: a low-inductance 0.1µF ceramic within 0.25 inches of the V_{IN} pin for high frequencies, and a 1 to 5µF solid tantalum within 0.5 inches of the V_C pin to provide an energy reservoir for the high peak output currents. A low-inductance .01µF bypass for the reference output is also recommended.

MICROPOWER STARTUP

Since the LX1823 draws about 460µA of supply current before turning on, a low power bleeder resistor from the rectified AC line supply is all that is required for startup. A start capacitor, C_S, is charged with the excess current from the bleeder resistor. When the turn-on threshold voltage is reached, the PWM circuit becomes active, energizing the power transistors. The additional operating current required by the PWM is then provided by a bootstrap winding on the main high-frequency power transformer.

SOFTSTART CIRCUIT / OUTPUT DUTY CYCLE LIMIT

The softstart pin of the LX1823 is held low when either the chip is in the micropower mode, or when a voltage greater than +1.4 volts is present at the I_{LIM}/S.D. pin. The maximum positive swing of the voltage error amplifier is clamped to the softstart pin voltage, providing a ramp-up of peak charging currents in the power semiconductors at turn-on.

In some cases, the duration of the shutdown signal can be too short to fully discharge the softstart capacitor. The illustrated resistor/discrete PNP transistor configuration can be used to shorten the discharge time by a factor of 50 or more. When the internal discharge transistor in the LX1823 turns on, current will flow through surge limit resistor R1. As the resistor drop approaches 0.6 volts, the external PNP turns on, providing a low resistance discharge path for the energy in the softstart capacitor. The capacitor will be rapidly discharged to +0.7 volts, which corresponds to zero duty cycle in the pulse width modulator.

To program the maximum output duty cycle, a resistor divider should be connected from the V_{REF} pin to the softstart pin. A resistor divider combination (R_2 + R_3) of less than 5kΩ achieves better than 2% voltage tolerance at the softstart pin.

FREQUENCY SYNCHRONIZATION

Two or three LX1823 oscillators may be locked together with the interconnection scheme shown, if the devices are within an inch or so of each other. A master unit is programmed for desired frequency with R_T and C_T as usual. The oscillators in the slave units are disabled by grounding C_T and by connecting R_T to V_{REF}. The logic in the slave units is locked to the clock of the master with the wire-OR connection shown.

Many LX1823's can be locked to a master system clock by wiring the oscillators as slave units, and distributing the master clock to each using a tree-fanout geometry.

APPLICATION FIGURES

FIGURE 9. — HIGH SPEED LAYOUT and BYPASSING

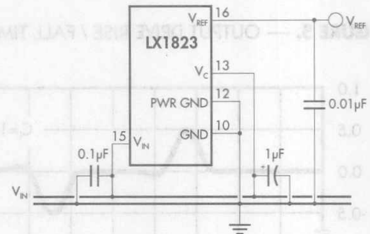


FIGURE 10. — MICROPOWER STARTUP

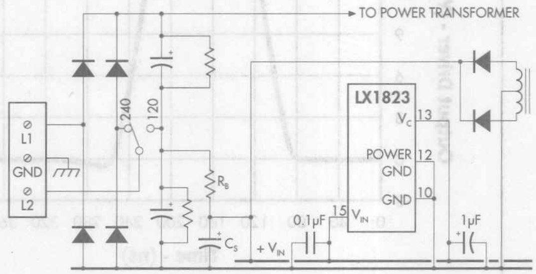


FIGURE 11. — SOFTSTART FAST RESET

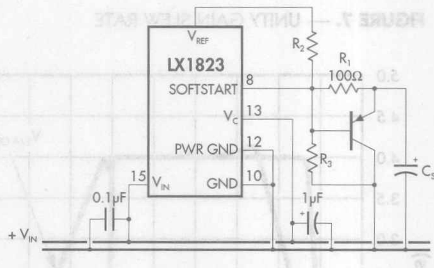
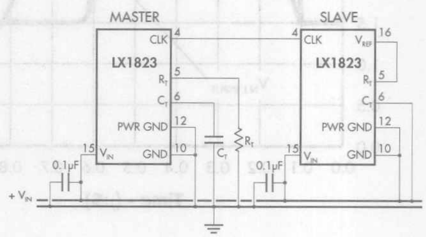


FIGURE 12. — OSCILLATOR SYCHRONIZATION



LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

OSCILLATOR

The oscillator frequency is programmed by external timing components R_T and C_T. A nominal +3 volts appears at the R_T pin. The current flowing through R_T is mirrored internally with a 1:1 ratio. This causes an identical current to flow out the C_T pin, charging the timing capacitor and generating a linear ramp. When the upper threshold of +2.7 volts is reached, a discharge network reduces the ramp voltage to +1.0 volts, where a new charge cycle begins.

The Clock output pin is LOW (+2.3 volts) during the charge cycle, and HIGH (+4.3 volts) during the discharge cycle. The Clock pin is driven by an NPN emitter follower, and so can be wire-ORed. Each Clock pin can drive a 1mA load. Since the internal current-source pulldown is approximately 400µA, the DC fan-out to other LX1823 Clock pins is at least two.

The type of capacitor selected for C_T is very important. At high frequencies, non-ideal characteristics such as effective series resistance (ESR), effective series inductance (ESL), dielectric loss and dielectric absorption all affect frequency accuracy and stability. RF capacitors such as silver mica, glass, polystyrene, or COG ceramics are recommended. Avoid high-K ceramics, which work best in DC bypass applications.

ERROR AMPLIFIER

The voltage error amplifier is a true operational amplifier with low-impedance output, and can be gain-stabilized using conventional feedback techniques. The typical DC open-loop gain is 100dB, with a single low-frequency pole at 100Hz.

The input connections to the error amplifier are determined by the polarity of the power supply output voltage. For positive supplies, the common-mode voltage is set to the reference of +5.1 volts and the feedback connections in Figure 14A are used. With negative outputs, the common-mode voltage is half the reference, and the feedback divider is connected between the negative output and the +5.1V reference, shown in Figure 14B.

OUTPUT DRIVER

The output driver is designed to provide up to 2 Amps peak output current. To minimize ringing on the output waveform, which can be destructive to both the power MOSFET and the PWM chip, the series inductance seen by the drivers should be as low as possible.

One solution is to keep the distance between the PWM and MOSFET gate as short as possible, and to use carbon composition series damping resistors. A Faraday shield to intercept radiated EMI from the power transistors is usually required with this choice.

A second approach is to place the MOSFETs some distance from the PWM chip, and use a series-terminated transmission line to preserve drive pulse fidelity. This will minimize noise radiated back to the sensitive analog circuitry of the LX1823. A Faraday shield may also be required.

If the driver is connected to an isolation transformer, or if kickback through gate-to-drain capacitance of the MOSFET is severe, clamp diodes may be required. Use a 2 Amp peak Schottky diode to limit undershoot to less than -0.3 volts.

APPLICATION FIGURES

FIGURE 13. — OSCILLATOR FUNCTIONAL DIAGRAM

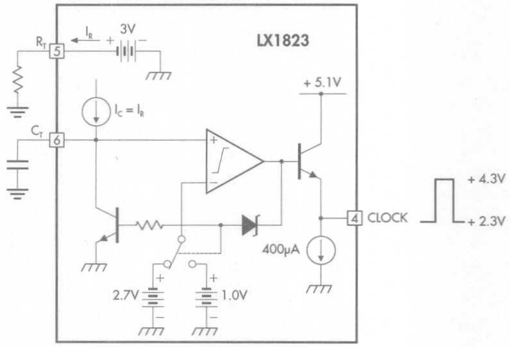


FIGURE 14. — VOLTAGE AMPLIFIER CONNECTIONS

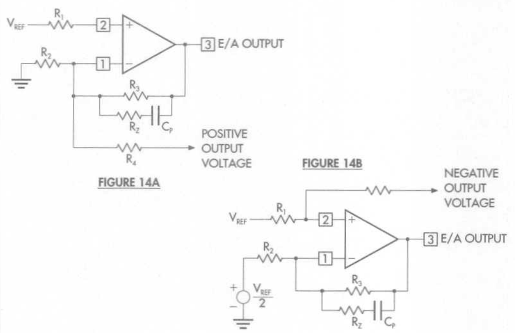
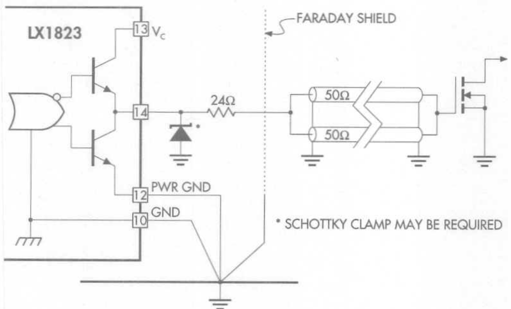


FIGURE 15. — DRIVING SHIELDED CABLE



LX5285

800mA Low Dropout Source And Sink 2.85V Regulator

LinFinity Microelectronics

The Infinite Power of Innovation

Preliminary Data Sheet

DESCRIPTION

The LX5285 is a low dropout fixed voltage source and sink regulator designed specifically for the Small Computer Systems Interface (SCSI) alternative 2 active termination. It is compatible with SCSI-1, SCSI-2, SCSI-3 and FAST-20 standards for both narrow and wide SCSI applications. The LX5285's (400mA) sink current capability make it compatible with active negation drivers without having to add external clamping components. Since the LX5285 is sink and source there is no deadband associated with the sink current capability (unlike many clamps) which keeps the signal line voltage lower giving greater noise margin upon assertion.

The LX5285's 1.2V maximum dropout ensures compatibility with existing SCSI systems. The ±1% maximum tolerance on the 2.85V output voltage ensures a tighter line driver current tolerance, thereby increasing system noise margin.

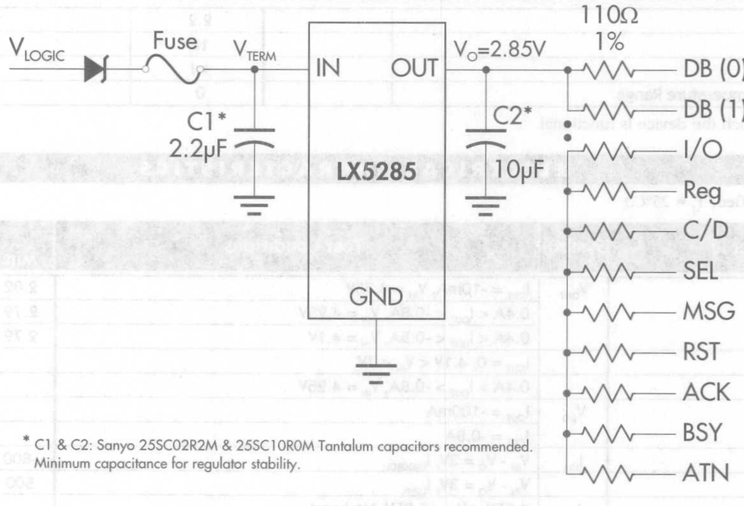
The LX5285 is packaged in a SOT-223 surface-mount package that offers low thermal resistance.

KEY FEATURES

- 2.85V FIXED OUTPUT FOR SCSI ACTIVE TERMINATION
- COMPATIBLE WITH SCSI-1, SCSI-2, SCSI-3, AND FAST-20
- ACTIVE NEGATION COMPATIBLE
- SPACE SAVING SOT-223 PACKAGE
- OUTPUT SOURCE CURRENT 800mA
- 1.2V MAXIMUM DROPOUT VOLTAGE AT I_O = -800mA
- ±1% MAXIMUM OUTPUT TOLERANCE AT T_J=25°C
- ±2% ABSOLUTE OUTPUT VARIATION
- INTERNAL OVERCURRENT LIMITING CIRCUITRY
- INTERNAL THERMAL OVERLOAD PROTECTION

PRODUCT HIGHLIGHT

LX5285 Block Diagram



* C1 & C2: Sanyo 25SC02R2M & 25SC10R0M Tantalum capacitors recommended. Minimum capacitance for regulator stability.

PACKAGE ORDER INFORMATION

T_A (°C)	ST Plastic SOT-223 3-pin
0 to 70	LX5285CST

Note: Available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5285CSTT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 Western Avenue, Garden Grove, CA. 92841

LX5285

800mA Low Dropout Source And Sink 2.85V Regulator

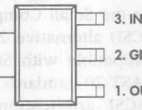
Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage (V_{IN}) 7V
Output Votlage 10V
Operating Junction Temperature
Plastic (ST Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C
Short-Circuit Protection .... Indefinite

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



ST PACKAGE
(Top View)

THERMAL DATA

ST PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	15°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	46°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
Input Capacitor		2.2			µF
Output Capacitor		10			µF
Input Voltage		4.1		7	V
Operating Ambient Temperature Range		0		70	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, T_J = 25°C.)

Parameter	Symbol	Test Conditions	LX5285			Units
			Min.	Typ.	Max.	
Output Voltage	V_{OUT}	I_{OUT} = -10mA, V_{IN} = 4.75V	2.82	2.85	2.88	V
		0.4A < I_{OUT} < -0.8A, V_{IN} = 4.25V	2.79	2.85	2.91	V
		0.4A < I_{OUT} < -0.5A, V_{IN} = 4.1V	2.79	2.85	2.91	V
Line Regulation		I_{OUT} = 0, 4.1V < V_{IN} < 7V			6	mV
Load Regulation		0.4A > I_{OUT} > -0.8A, V_{IN} = 4.25V			10	mV
Dropout Voltage	V_{DO}	I_{OUT} = -100mA			1.1	V
		I_{OUT} = -0.8A			1.2	V
Current Limit	I_{LIM}	V_{IN} - V_O = 3V, $I_{LSOURCE}$	-800	-1000		mA
		V_{IN} - V_O = 3V, I_{LSINK}	500			mA
Supply Current	I_{CC}	4.25V < V_{IN} < 5.25V, No Load		6	10	mA
Short Circuit Current	I_{SL}	V_{OUT} = 0V, I_{SC-}	800			mA
		V_{OUT} = V_{IN}, I_{SC+}	500			mA
Thermal Regulation		T_A = 25°C, 30mS Pulses			0.1	%/W
Thermal Shutdown				165		°C
Ripple Rejection		F Ripple= 120Hz, 0.5V_{P-P}	60	80		dB
Temp Drift		0°C < T_J < 125°C			0.5	%
Output Noise		(% of V_{OUT}), 10Hz < 10kHz			0.003	%

LINFINITY
MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX7001

TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

DESCRIPTION

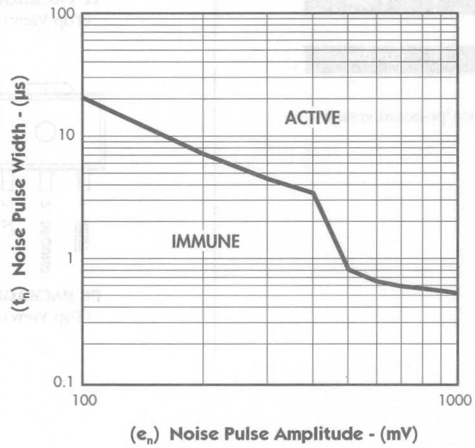
The LX7001 is an improved undervoltage sensing circuit specifically designed for use as a reset controller in microprocessor-based systems. Today's complex miniaturized systems present difficult challanges to the system designer such as overcoming spurious noise problems. The LX7001 is optimized for systems that must be tolerant of high-speed power supply glitches caused by high-speed logic transitions and similar switching phenomena. The LX7001 offers a unique stage that couples glitch immunity with a micropower, ultra-stable band-gap reference for precision sensing of undervoltage conditions. It offers the designer an economical, space-efficient solution for low supply voltage detection when used in combination with a single pull-up resistor. Adding one capacitor offers the functionality of a programmable delay time after power returns. Additionally, the LX7001 offers excellent temperature stability. A high-quality trimmed voltage reference and bias circuit permit very accurate and repeatable undervoltage sensing. The remaining blocks consist of a comparator with hysteresis, high current clamping diode and open collector output stage capable of sinking up to 60mA. The LX7001's $\overline{\text{RESET}}$ output is specified to be fully functional at V_{IN}=1V.

KEY FEATURES

- **FULLY CHARACTERIZED, TRANSIENT IMMUNE INPUT STAGE** (See Product Highlight)
- **MONITORS 5V SUPPLIES** (V_{TRIP}=4.6V typ)
- **OUTPUTS FULLY DEFINED AT V_{CC}=1V**
- **ULTRA-LOW SUPPLY CURRENT** (500µa max. over temp)
- TEMPERATURE COMPENSATED I_{CC} FOR EXTREMELY STABLE CURRENT CONSUMPTION
- µP RESET FUNCTION PROGRAMMABLE WITH 1 EXTERNAL RESISTOR AND CAPACITOR
- COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34064
- PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064/MC34164

PRODUCT HIGHLIGHT

INPUT TRANSIENT IMMUNITY



APPLICATIONS

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 5V SUPPLIES
- SIMPLE 5V UNDERVOLTAGE DETECTION

PACKAGE ORDER INFORMATION

T_A (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin	Y Ceramic Dip 8-pin
0 to 70	LX7001CDM	LX7001CLP	LX7001CPK	—
-40 to 85	LX7001IDM	LX7001ILP	LX7001IPK	—
-55 to 125	—	—	—	LX7001MY

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX7001CDMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX7001

TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... -1V to 12V
RESET Output Voltage (V_{OUT}) .... -1V to 12V
Output Sink Current (I_{OL}) .... Internally Limited (mA)
Clamp Diode Forward Current (I_F), Pin 1 to pin 2 .... 100mA
Operating Junction Temperature
  Ceramic (Y - Package) .... 150°C
  Plastic (DM, LP, PK - Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

PK PACKAGE:

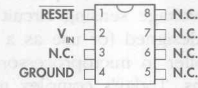
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	71°C/W

Y PACKAGE:

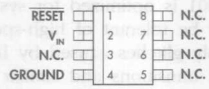
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

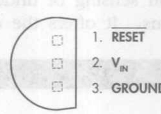
PACKAGE PIN OUTS



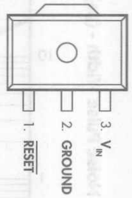
Y PACKAGE
(Top View)



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)



PK PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Supply Voltage	V_{IN}	1		10	V
$\overline{\text{RESET}}$ Output Voltage	V_{OUT}		10		V
Clamp Diode Forward Current	I_F		50mA		
Operating Ambient Temperature Range:					
LX7001C		0		70	°C
LX7001I		-25		85	°C
LX7001M		-55		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C for the LX7001C, -40°C ≤ T_A ≤ 85°C for the LX7001I, and -55°C ≤ T_A ≤ 125°C for the LX7001M. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

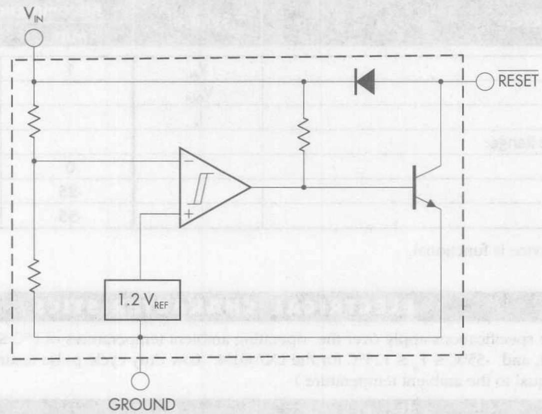
Parameter	Symbol	Test Conditions	LX7001C/7001I/7001M Min.	Typ.	Max.	Units
Comparator Section						
Threshold Voltage						
High State Output	V_{T+}	V_{IN} Increasing — 4V to 5V	4.5	4.62	4.7	V
Low State Output	V_{T-}	V_{IN} Decreasing — 5V to 4V	4.5	4.60	4.7	V
Hysteresis	V_H		0.01	0.02	0.05	V
$\overline{\text{RESET}}$ Output Section						
Output Sink Saturation Voltage	V_{OL}	V_{IN} = 4.0V, I_{OL} = 8.0mA		0.06	1.0	V
		V_{IN} = 4.0V, I_{OL} = 2.0mA		0.25	0.4	V
		V_{IN} = 1.0V, I_{OL} = 0.1mA		0.3	0.1	V
Output Sink Current	I_{OL}	V_{OUT} = 4.0V	10	40	60	mA
Output Off-State Leakage	I_{OH}	V_{OUT} = 5.0V		0.01	0.5	µA
		V_{OUT} = 10V		0.02	2.0	µA
Clamp Diode Forward Voltage	V_F	Pin 1 to pin 2, I_F = 10mA	0.6	0.82	1.2	V
Total Device						
Supply Current	I_{CC}	V_{IN} = 5.0V		345	500	µA

LX7001

TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

BLOCK DIAGRAM



GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

1. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE
2. POWER-UP RESET VOLTAGE
3. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE
4. THRESHOLD VOLTAGE vs. TEMPERATURE
5. THRESHOLD HYSTERESIS vs. TEMPERATURE
6. SUPPLY CURRENT vs. INPUT VOLTAGE
7. SUPPLY CURRENT vs. TEMPERATURE
8. LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE
9. LOW LEVEL OUTPUT VOLTAGE vs. LOW LEVEL OUTPUT CURRENT
10. VOLTAGE vs. CLAMP DIODE FORWARD CURRENT
11. PROPAGATION DELAY
12. LOW LEVEL OUTPUT VOLTAGE vs. TEMPERATURE

FIGURE INDEX

Application Circuits

FIGURE #

13. LOW VOLTAGE MICROPROCESSOR RESET
14. SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V
15. VOLTAGE MONITOR
16. MOSFET LOW VOLTAGE GATE DRIVE PROTECTION
17. LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. INPUT VOLTAGE

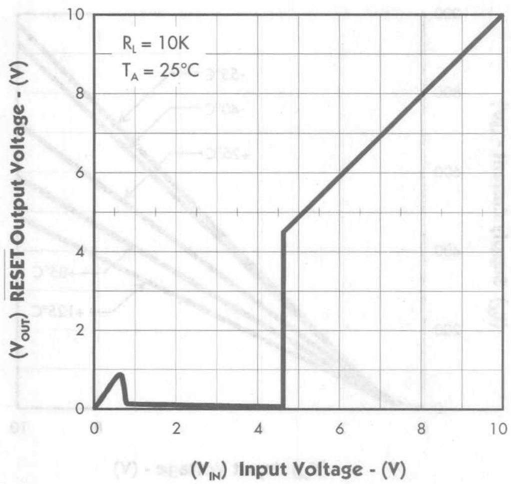


FIGURE 2. — POWER-UP $\overline{\text{RESET}}$ VOLTAGE

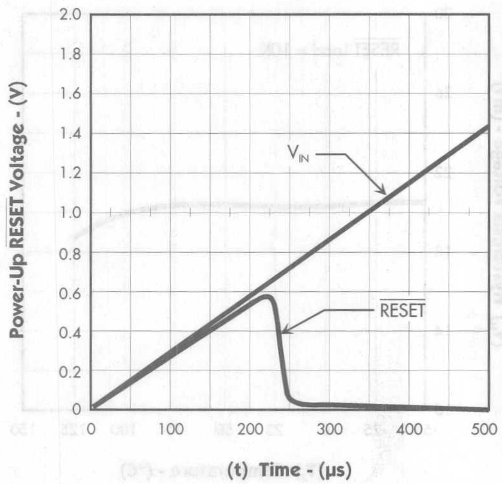


FIGURE 3. — $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. INPUT VOLTAGE

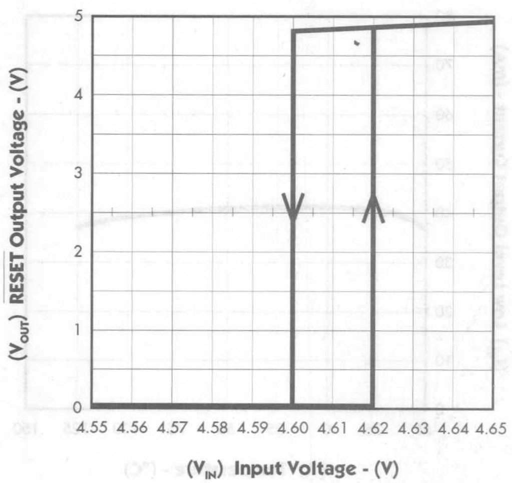
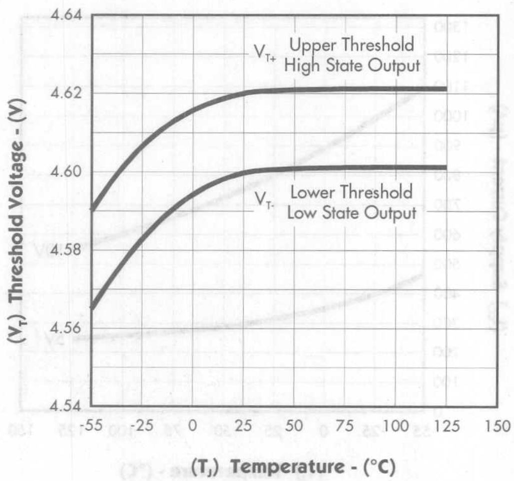


FIGURE 4. — THRESHOLD VOLTAGE vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — THRESHOLD HYSTERESIS vs. TEMPERATURE

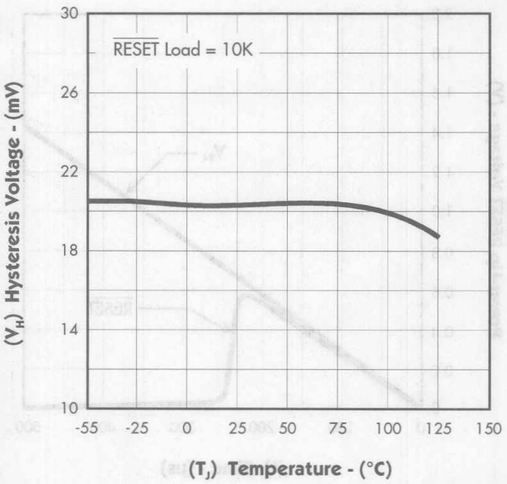


FIGURE 6. — SUPPLY CURRENT vs. INPUT VOLTAGE

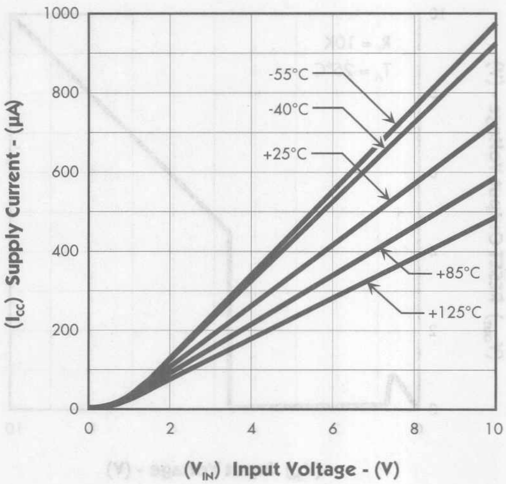


FIGURE 7. — SUPPLY CURRENT vs. TEMPERATURE

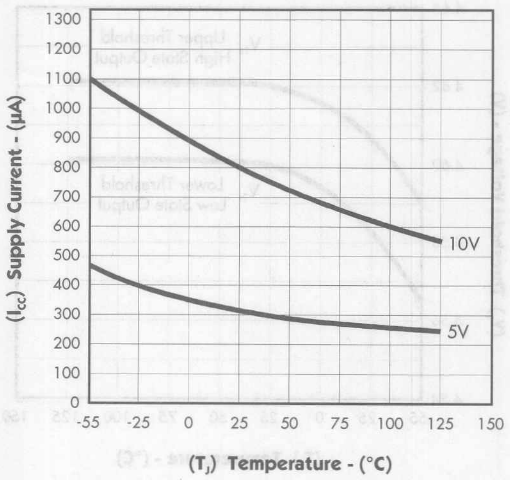
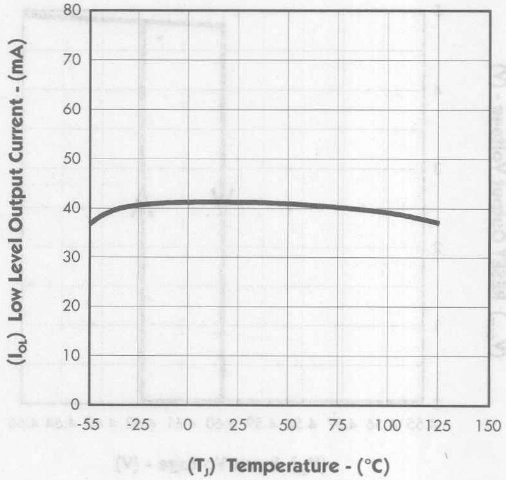


FIGURE 8. — LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 9. — LOW LEVEL OUTPUT VOLTAGE vs. LOW LEVEL OUTPUT CURRENT

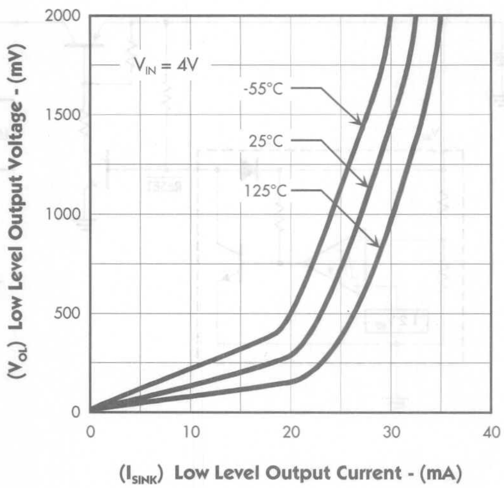


FIGURE 10. — VOLTAGE vs. CLAMP DIODE FORWARD CURRENT

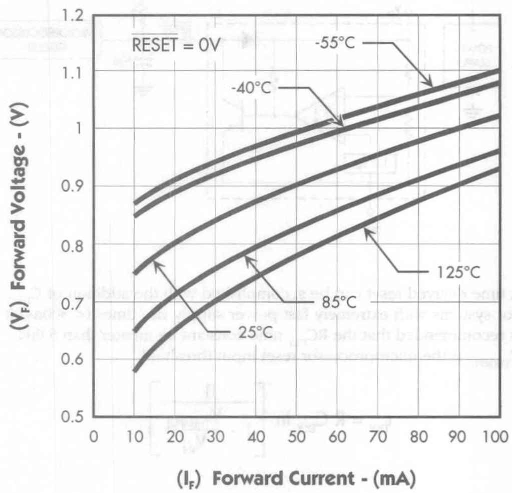


FIGURE 11. — PROPAGATION DELAY

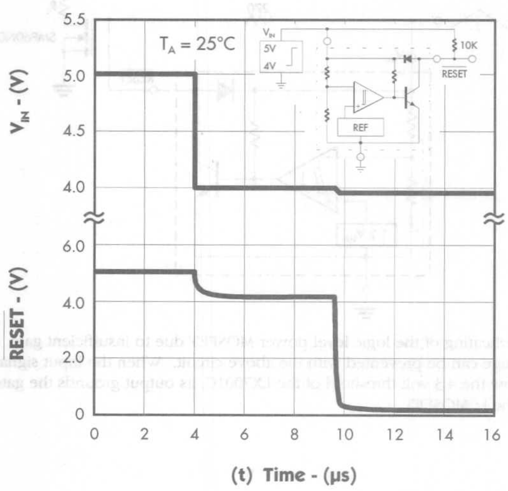
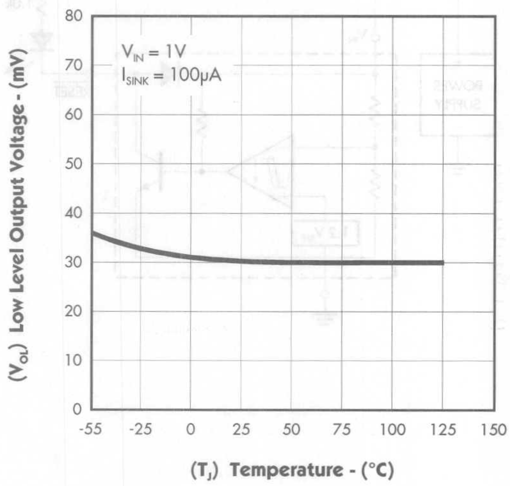


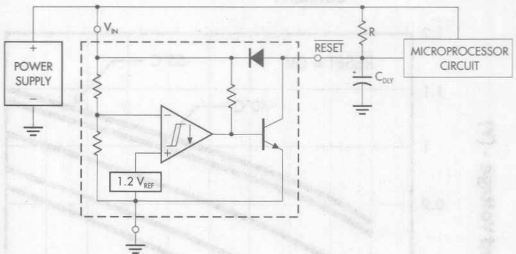
FIGURE 12. — LOW LEVEL OUTPUT VOLTAGE vs. TEMPERATURE



LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

FIGURE 13. — LOW VOLTAGE MICROPROCESSOR RESET.



A time delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC_{DLY} time constant be greater than 5.0µs. $V_{TH(MPU)}$ is the microprocessor reset input threshold.

$$t_{DLY} = R\,C_{DLY}\,\ln\left[\frac{1}{1-\dfrac{V_{TH(MPU)}}{V_{IN}}}\right]$$

FIGURE 14. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V.

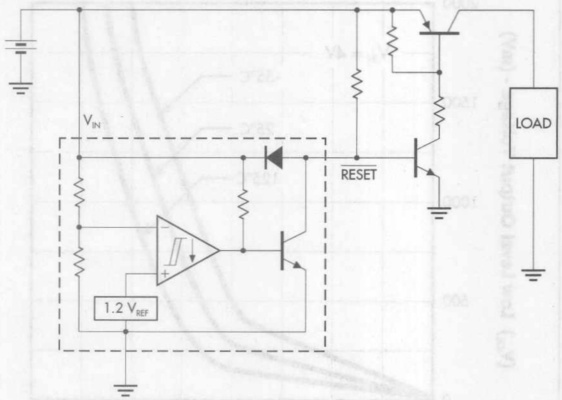


FIGURE 15. — VOLTAGE MONITOR.

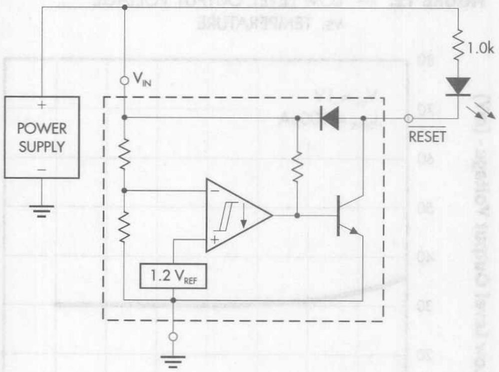
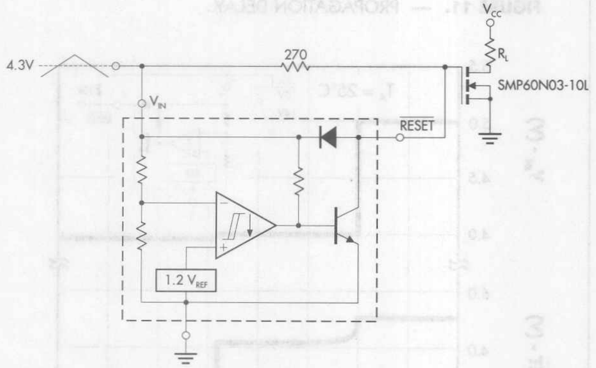


FIGURE 16. — MOSFET LOW VOLTAGE GATE DRIVE PROTECTION.

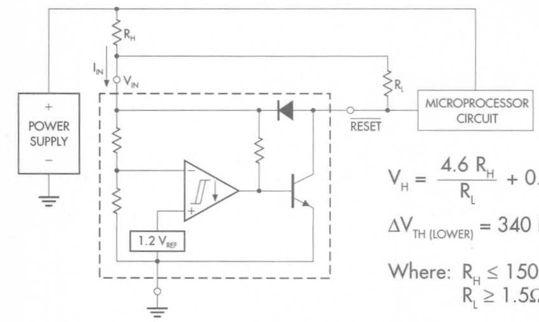


Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.3 volt threshold of the LX7001C, its output grounds the gate of the L[2] MOSFET.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS (Con't.)

FIGURE 17. — LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS.



$$V_H = \frac{4.6\ R_H}{R_L} + 0.02$$

$$\Delta V_{TH\ (LOWER)} = 340\ R_H \times 10^{-6}$$

Where: $R_H \leq 150\Omega$
$R_L \geq 1.5\Omega \leq 10k\Omega$

Comparator hysteresis can be increased with the addition of resistor R_H. The hysteresis equation has been simplified and does not account for the change of input current I_{IN} as V_{CC} crosses the comparator threshold. An increase of the lower threshold $\Delta V_{TH\ (LOWER)}$ will be observed due to I_{IN} which is typically 340µA at 4.59V. The equations are accurate to ±10% with R_H less than 150Ω and R_L between 1.5kΩ and 10kΩ.

TEST DATA

V_H (mV)	ΔV_{TH} (mV)	R_H (Ω)	R_L (Ω)
20	0	0	0
51	3.4	10	1.5
40	6.8	20	4.7
81	6.8	20	1.5
71	10	30	2.7
112	10	30	1.5
100	16	47	2.7
164	16	47	1.5
190	34	100	2.7
327	34	100	1.5
276	51	150	2.7
480	51	150	1.5

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX7705

5V SUPPLY VOLTAGE SUPERVISOR WITH REFERENCE

PRELIMINARY DATA SHEET

DESCRIPTION

The LX7705 series of voltage supervisory circuits are greatly improved monolithic integrated circuits for microprocessor and microcontroller supervisory applications. Addressing today's low voltage systems, the LX7705 monitors a 5V supply voltage with full operation at a minimum V_{CC} level of 3.6V. Additionally, to prevent unknown or unwanted states, the RESET and RESET-BAR outputs are fully defined at the 1V level during power-up and power-down sequences. For today's "Green" systems, the LX7705 consumes only 1.4mA of quiescent current, offering a 60% improvement over competing products.

Operationally, the LX7705 monitors the supply voltage at the sense input. As the power supply voltage dips below the threshold voltage of 4.55V, the device generates a RESET-BAR signal for the microprocessor. The output will remain low until the power supply voltage returns to within specified values and the programmed delay has expired. The delay is fully programmable by the user with a single external capacitor. The time delay is calculated by the following formula:

$$t_D = 1.25 \times 10^4 \times C_T$$

where C_T is in Farads (F) and t_D is in seconds.

Power-up sequencing is assisted by the LX7705 as its outputs are in a fully known low state once the power supply voltage exceeds 1V. During power-down, the outputs are also defined until the supply reaches 1V. Below 1V, the outputs are in an undefined state.

Improvements such as reduced propagation delay times, sharp output rise and fall times, and ultra-low leakage outputs, make the LX7705 the supply voltage supervisor of choice for all microprocessor and microcontroller applications. Functionally, the LX7705 also eliminates the need for a bypass capacitor on the Reference Output pin.

KEY FEATURES

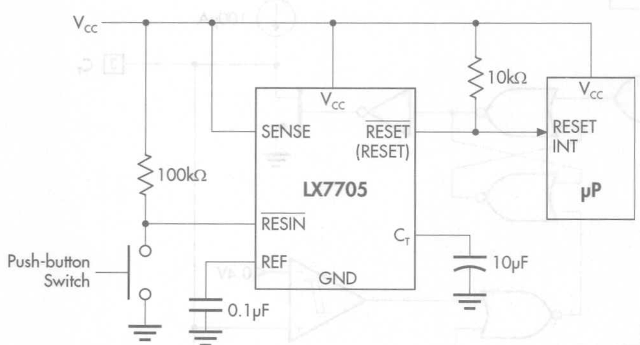
- MONITORS 5V SUPPLIES
- OUTPUT FULLY DEFINED AT V_{CC} = 1V
- IMPROVED OUTPUT LEAKAGE < 10µA
- LOW 1.4mA TYPICAL I_{CC}
- RESET TF = 15ns typ.
- 2.5V EXTERNAL 30mA REFERENCE
- PROGRAMMABLE RESET DELAY
- TRUE / COMPLIMENTARY OUTPUTS
- EXTERNAL TRIGGERED RESET INPUT
- UPGRADED COMPATIBLE WITH TL7705A
- ELIMINATES NEED FOR CAPACITOR ON REF PIN

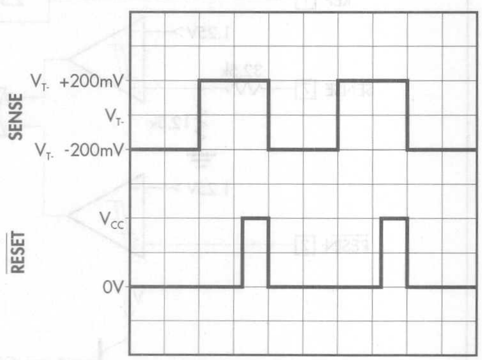
APPLICATIONS

- ALL MICROPROCESSOR- AND MICROCONTROLLER-BASED DESIGNS

PRODUCT HIGHLIGHT

RESET CONTROLLER WITH 125MS DELAY





100ms / Div.

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
0 to 70	LX7705CM	LX7705CDM
-40 to 85	LX7705IM	LX7705IDM

Note: All surface mount packages are available in Tape & Reel, append the letter "T" to part number (i.e. LX7705CDMT).

FOR FURTHER INFORMATION CALL (714) 898-8121

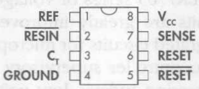
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

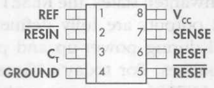
Supply Voltage (V_{CC})	15V
Input Voltage Range (RESIN)	-0.3V to V_{CC}
Input Voltage Range (SENSE)	-0.3V to V_{CC}
High-Level Output Current (RESET)	-100mA
Low-Level Output Current ($\overline{RESET}$)	30mA
Operating Junction Temperature	
Plastic (M & DM Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



M PACKAGE
(Top View)



DM PACKAGE
(Top View)

THERMAL DATA

M PACKAGE:

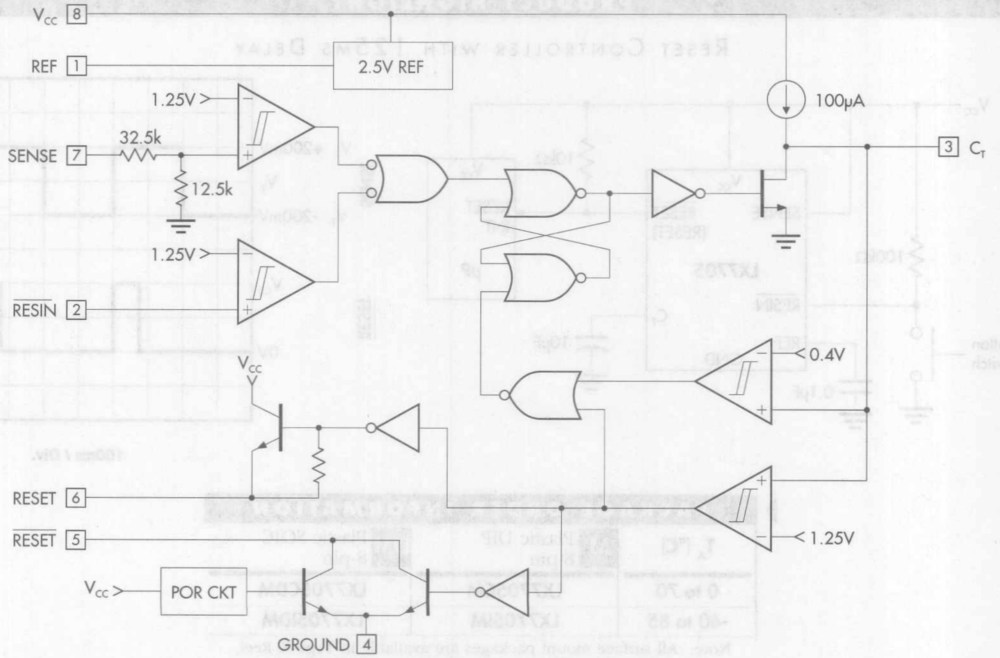
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

5V Supply Voltage Supervisor with Reference

Preliminary Data Sheet

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage	V_{CC}	3.6		12	V
High-Level Input Voltage at $\overline{RESIN}$	V_{IH}	2			V
Low-Level Input Voltage at $\overline{RESIN}$	V_{IL}			0.8	V
Input Voltage (SENSE)	V_I	0		10	V
Output Current At REF	I_{OUT}			30	mA
High-Level Output Current (RESET)	I_{OH}			-16	mA
Low-Level Output Current ($\overline{RESET}$)	I_{OL}			16	mA
Capacitor Selection At REF					
Minimum Range		0		100	pF
Maximum Range		0.1		10	µF
Operating Free-Air Temperature Range:					
LX7705C	T_A	0		70	°C
LX7705I	T_A	-40		85	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX7705C with $0°C \le T_A \le 70°C$, LX7705I with $-40°C \le T_A \le 85°C$.)

Parameter	Symbol	Test Conditions (Note 3)	LX7705 Min.	Typ.	Max.	Units
Power-Up Reset Voltage	V_{RES}	I_{OL} ($\overline{RESET}$) = 2mA, See Note 5			1	V
High-Level Output Voltage (RESET)	V_{OH}	I_{OH} = -16mA	V_{CC} - 1.5			V
Low-Level Output Voltage ($\overline{RESET}$)	V_{OL}	I_{OL} = 16mA			0.4	V
Reference Voltage (REF)	V_{REF}	T_A = 25°C, I_{OUT} = No Load	2.48	2.53	2.58	V
Negative-Going Threshold Voltage (SENSE)	V_{T-}	T_A = 25°C	4.5	4.55	4.6	V
Hysteresis (V_{T+} - V_{T-}) (SENSE)	V_{HYS}	T_A = 25°C		15		mV
Input Current ($\overline{RESIN}$)	I_I	V_I = 2.4V to V_{CC}			1	µA
		V_I = 0.4V			-1	µA
High-Level Output Current ($\overline{RESET}$)	I_{OH}	V_O = 12V			10	µA
Low-Level Output Current (RESET)	I_{OL}	V_O = 0V			-10	µA
Supply Current	I_{CC}	SENSE = 4.75V and outputs open		1.4	2	mA
Minimum Pulse Duration at SENSE Inputs to Switch Outputs	$t_{WS(MIN)}$	V_{IH} = V_{T-} + 200mV		0.1		µs
		V_{IL} = V_{T-} - 200mV		0.1		µs
Propagation Delay Time from $\overline{RESIN}$ to $\overline{RESET}$	t_{PD}	V_{CC} = 5V		0.3		µs
SENSE to $\overline{RESET}$		V_{CC} = 5V		0.3		µs
Rise Time (Note 4)	t_R	RESET, V_{CC} = 5V		15		ns
		$\overline{RESET}$, V_{CC} = 5V		280		ns
Fall Time (Note 4)	t_F	RESET, V_{CC} = 5V		220		ns
		$\overline{RESET}$, V_{CC} = 5V		15		ns

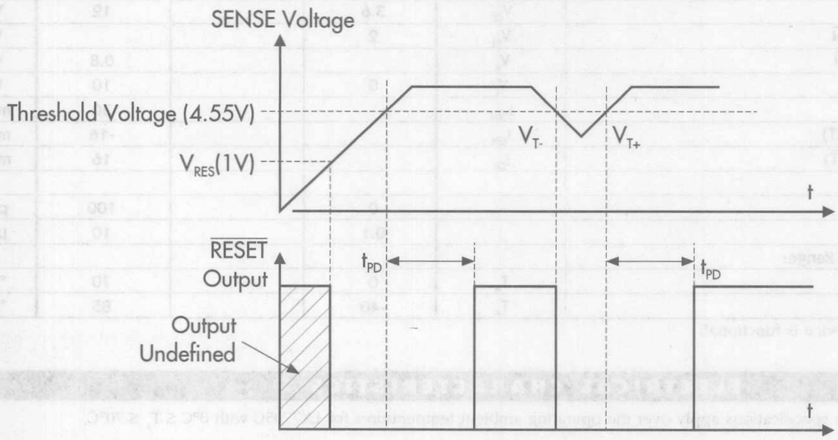
Note 3. All electrical characteristics are measured with 0.1µF capacitors connected at REF, C_T and V_{CC} to GND.
Note 4. The rise and fall times are measured with a 4.7kΩ load resistor at RESET and $\overline{RESET}$.
Note 5. The lowest supply voltage at which $\overline{RESET}$ becomes active.

5V Supply Voltage Supervisor with Reference

PRELIMINARY DATA SHEET

PARAMETER MEASUREMENT INFORMATION

Timing Diagram



GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

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THE INFINITE POWER OF INNOVATION

LX8020-xx/8020A-xx

ULTRA LOW DROP OUT REGULATOR (ULDO™)

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8020-xx/8020A-xx series of Ultra-Low Drop Out (ULDO™) Voltage Regulators is the latest advance in highly efficient power supply products for battery operated systems. Using the LX8020-xx/8020A-xx in your equipment design provides a significant advantage in operating efficiency, resulting in longer system operating life. See the System Up-Time Figure featured below. A newly-patented design technique coupled with Linfinity BiCMOS wafer process technology not only delivers efficiency but space savings, too! Unlike most LDO's that require bulky compensation capacitors, the LX8020-xx/8020A-xx series is very stable over no-load to full-load conditions using 0603 surface-mount Z5U 0.1µF output/ input capacitors. See the Application Notes at the end of this document for assistance in selecting the best capacitor for your application.

The patented CMOS pass element design technique delivers a lot more than high efficiency. A key advantage to this technique is constant quiescent operating current over the full-load range of the device. Unlike bipolar equivalents, which require increasing base drive with increasing loads, the LX8020-xx/8020A-xx is totally independent. Plus, the LX8020-xx/ 8020A-xx does not exhibit the unwieldy high-current demands of a bipolar device entering the drop out region (saturation phenomena). For example, for a given pass element (typ. a pnp transistor) load, there is a larger than normal amount of stored charge in the base region. This results in a larger base current contribution to the load. In addition, since the base-collector junction is now forward biased, there is a new base current contribution due to injection of carriers from the base to the collector. The combination of these two events results in a base current which is substantially larger during drop-out, resulting in increased device operating current. This term is commonly referred to as *forced beta*. Additionally, as load demands increase, the forced beta condition worsens. The event occurs at the time when your system least wants or needs increasing current demands, at the end of battery life.

Another unique feature of the LX8020-xx/8020A-xx delivers is superb Line and Load regulation from DC out to extraordinarily high frequencies. This is very important for systems which have continuously varying load and line conditions. The clear advantage of excellent AC response is the overall reduction in output capacitor size and value. Using the LX8020-xx/ 8020A-xx family of ULDO's in size, weight and power sensitive applications enhances your applications performance beyond yesterday's bipolar solutions.

Other advantages the LX8020-xx/ 8020A-xx offers include current limiting, thermal protection and reverse battery (no battery) protection. The LX8020-xx/8020A-xx Family is offered in a variety of output voltage and packaging options.

KEY FEATURES

- INDUSTRY'S LOWEST DROP OUT VOLTAGE (SEE SPECIFIC DEVICE SPEC)
- QUIESCENT OPERATING CURRENT CONSTANT OVER LOAD RANGE (SEE SPECIFIC DEVICE SPEC)
- MINIMAL OUTPUT CAPACITANCE NECESSARY FOR STABLE OPERATION (0.1µF)
- HIGH LEVELS OF LOAD AND LINE REGULATION MAINTAINED OVER WIDE FREQUENCY RANGE
- SHORT CIRCUIT PROTECTION
- REVERSE BATTERY PROTECTION WITH NO BATTERY FEATURE
- FIXED AND ADJUSTABLE OUTPUT VOLTAGES AVAILABLE

APPLICATIONS

- PORTABLE PHONES
- PORTABLE PAGERS
- NOTEBOOK COMPUTER POWER SUPPLIES
- BATTERY CHARGERS

AVAILABLE OPTIONS PER PART #

Part #	Output Voltage
LX8020-28	2.85V
LX8020-30	3V
LX8020-33	3.3V
LX8020-48	4.8V
LX8020-50	5V
LX8020-00	Adjustable

PACKAGE ORDER INFORMATION

T_A (°C)	Initial Tolerance	LP Plastic T0-92 3-pin	DM Plastic SOIC 8-pin
0 to 70	2%	LX8020-xxCLP	LX8020-xxCDM
	1%	LX8020A-xxCLP	LX8020A-xxCDM
-40 to 85	2%	LX8020-xxILP	LX8020-xxIDM
	1%	LX8020A-xxILP	LX8020A-xxIDM

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8020-xxDMT) "xx" refers to output voltage, please see table above.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage 10V
Operating Junction Temperature
  Plastic (LP, DM Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

LP PACKAGE:

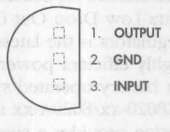
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

DM PACKAGE:

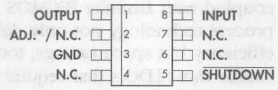
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

PACKAGE PIN OUTS



LP PACKAGE
(Top View)



DM PACKAGE
(Top View)

* Pin for Adjustable version *only.*

LINFINITY
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RECOMMENDED OPERATING CONDITIONS (Note 4)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Voltage Range	V_{IN}, V_{MIN} to V_{MAX}			10	V
Output Current Range	I_{OUT}			200	mA
Short Circuit Range	I_{SC}		500		mA
Input Capacitor Range	C_{IN}	0.1		10	µF
Output Capacitor Range	C_{OUT}	0.1		10	µF
Junction Temp Range	°C		125		°C
Reverse Voltage	V_{REV}			-10	V

ELECTRICAL CHARACTERISTICS

(Conditions are T = 25°C; I_{OUT} = 10mA; V_{DIFF} = V_{IN}-V_{OUT} = 1V; C_{IN} = 0.4µF; C_{OUT} = 0.4µF; and V_{ENABLE} = V_{IN}; unless noted.)

Parameter		Symbol	Test Conditions	LX8020-xx / 8020A-xx Min.	Typ.	Max.	Units
Output Voltage	LX8020-xx	V_{OUT}	T_A = 25°C, No Load	-2		+2	%
	LX8020A-xx		T_A = 25°C, No Load	-1		+1	%
Output Voltage TC			T = 0 to 70°C		100		ppm/°C
Line Regulation	100Hz		I_{OUT} = 50mA, ΔV_{IN} = 200mVpp		70		db
	1KHz		I_{OUT} = 50mA, ΔV_{IN} = 200mVpp		65		db
	10KHz		I_{OUT} = 50mA, ΔV_{IN} = 200mVpp		50		db
	100KHz		I_{OUT} = 50mA, ΔV_{IN} = 200mVpp		30		db
Load Regulation			ΔI_{OUT} = 1mA to 200mA		0.5		%
Dropout Voltage		V_{DO}	I_{OUT} = 200mA		200		mV
			I_{OUT} = 50mA		50		mV
Operating or Ground Current	LX8020-50 /A-50				300		µA
	LX8020-48 /A-48				300		µA
	LX8020-33 /A-33				300		µA
	LX8020-30 /A-30				210		µA
	LX8020-28 /A-28				210		µA
	LX8020-00 /A-00				210		µA
Ground Current Regulation Over Input			ΔV_{DIFF} = 1V to 5V		40		µA
Ground Current Regulation Over Load			ΔI_{OUT} = 1mA to 200mA		20		µA
Enable Threshold				1.2		1.8	V
Off-mode Input Leakage Current			V_{ENABLE} = 0V, V_{IN} = 10V		1		µA
Reverse Output Leakage Current	V_{IN} pin = Open		V_{ENABLE} = 0V, V_{OUT} = Output Voltage		1		µA
	V_{IN} pin = Ground		V_{ENABLE} = 0V, V_{OUT} = Output Voltage		100		µA
Output Noise		en	T_A = 25°C		TBD		nV/√Hz

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

1. V_{OUT} vs. TEMP
2. V_{IN} vs. V_{OUT}, SHOW START-UP / SHUTDOWN
3. TURN-ON RESPONSE TIME V_{IN} AND V_{OUT} vs. TIME
4. I_Q vs. I_O
5. I_Q vs. TEMP
6. I_Q vs. V_{DO}
7. V_{DO} vs. TEMP
8. V_{DO} vs. I_{OUT}
9. I_{CL} vs. TEMP AND V_{ID}
10. R_{OUT} vs. f
11. RIPPLE REJECTION vs. F AND I_O
12. LINE TRANSIENT RESPONSE vs. TIME
13. LOAD TRANSIENT RESPONSE vs. TIME, USING DIFFERENT C_{OUT} VALUES
14. P_K-P_K NOISE, 0.1Hz to 10Hz
15. BROADBAND NOISE, 1Hz to 1MHz

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LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX8383/8383A

7.5A Low Dropout Positive Adjustable Regulators

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8383/8383A are positive adjustable regulators designed to provide 7.5A output current. All internal circuitry is designed to operate down to a 1V input-to-output differential, so the LX8383/8383A can operate with greater efficiency than previously available devices. The dropout voltage for each product is fully specified as a function of load current. **Dropout is guaranteed at a maximum of 1.3V** for the LX8383A and **1.5V** for the LX8383, at maximum output current, decreasing at lower load currents. In addition, on-chip trimming adjusts the reference voltage to 1%.

The LX8383/83A devices are pin-compatible with earlier 3-terminal regulators, such as the 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8383/83A's quiescent current flows into the load, thereby increasing efficiency. This feature contrasts with PNP regulators, where up to 10% of the output current is wasted as quiescent current. The LX8383I/8383AI is specified over the industrial temperature range of -25°C to +125°C and the LX8383C/8383AC is specified over the commercial range of 0°C to +125°C. The LX8383M/8383AM is specified over the military temperature range of -55°C to +125°C.

KEY FEATURES

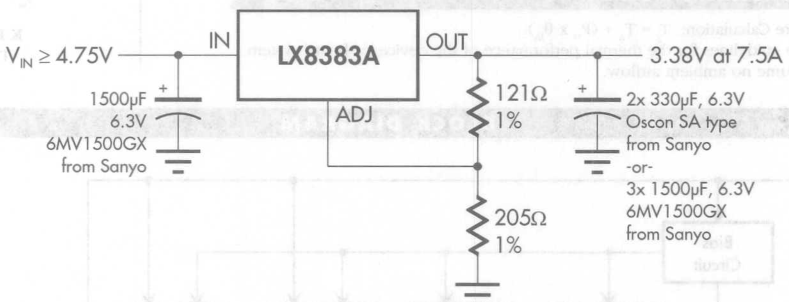
- THREE-TERMINAL ADJUSTABLE
- GUARANTEED < 1.3V HEADROOM AT 7.5A (LX8383A)
- GUARANTEED < 1.5V HEADROOM AT 7.5A (LX8383)
- OUTPUT CURRENT OF 7.5A MINIMUM
- 0.015% LINE REGULATION
- 0.15% LOAD REGULATION

APPLICATIONS

- PENTIUM® PROCESSOR APPLICATIONS
- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

PRODUCT HIGHLIGHT

3.3V, 7.5A REGULATOR



Application of the LX8383A for the standard voltage (non VRE) Pentium Processor motherboard with less than 130mV dynamic response to a 7.5A load transient.

PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal	K TO-3 Metal Can 3-Terminal
0 to 125	1.5V	LX8383-00CP	LX8383-00CV	—
	1.3V	LX8383A-00CP	LX8383A-00CV	—
-25 to 125	1.5V	LX8383-00IP	LX8383-00IV	LX8383-00IK
	1.3V	LX8383A-00IP	LX8383A-00IV	LX8383A-00IK
-55 to 125	1.5V	—	—	LX8383-00MK
	1.3V	—	—	LX8383A-00MK

FOR FURTHER INFORMATION CALL (714) 898-8121

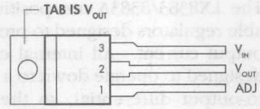
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

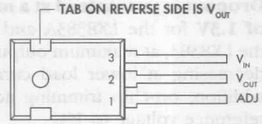
Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
  Hermetic (K - Package) .... 150°C
  Plastic (V - Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

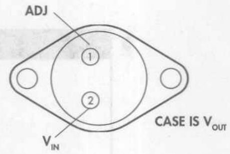
PACKAGE PIN OUTS



P PACKAGE
(Top View)



V PACKAGE
(Top View)



K PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

V PACKAGE:

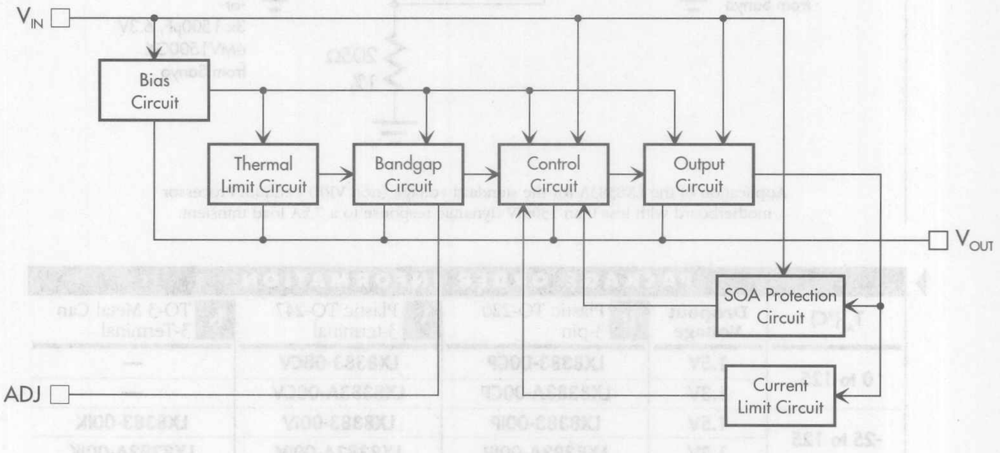
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	35°C/W

K PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JC}	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	35°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

7.5A Low Dropout Positive Adjustable Regulators

Preliminary Data Sheet

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8383C/8383AC with 0°C ≤ T_A ≤ 125°C, the LX8383I/8383AI with -25°C ≤ T_A ≤ 125°C, and the LX8383M/8383AM with -55°C ≤ T_A ≤ 125°C; V_{IN} - V_O = 3V; I_O = 7.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8383C/8383I			Units
			Min.	Typ.	Max.	
Reference Voltage (Note 4)	V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
		10mA ≤ I_O ≤ $I_{O\,(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 10V, P ≤ P_{MAX}	1.225	1.250	1.270	V
Line Regulation (Note 2)	d V_R (IN)	1.5V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 7V		0.015	0.2	%
		1.5V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 10V		0.035	0.3	%
Load Regulation (Note 2)	d V_R (L)	V_O ≥ V_{REF}, V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 7.5A, T_A = 25°C		0.15	0.4	%
		V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 7.5A		0.3	0.5	%
Thermal Regulation (Note 3)	d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		V_O = 5V, f = 120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 6.5V				
		C_{ADJ} = 10µF, T_A = 25°C, I_O = 7.5A	65	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change (Note 4)	Δ I_{ADJ}	10mA ≤ I_O ≤ $I_{O\,(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 10V		0.2	5	µA
Dropout Voltage LX8383A	Δ V	ΔV_{REF} = 1%, I_O = 7.5A		1	1.3	V
LX8383		ΔV_{REF} = 1%, I_O = 7.5A		1.2	1.5	V
Minimum Load Current	$I_{O\,(MIN)}$	V_{IN} ≤ 10V		2	10	mA
Maximum Output Current (Note 5)	$I_{O\,(MAX)}$	V_{IN} - V_O ≤ 7V	7.5	9.5		A
Temperature Stability (Note 3)	d V_O (T)			0.25		%
Long Term Stability (Note 3)	d V_O (t)	T_A = 125°C, 1000 hours		0.3	1	%
RMS Output Noise (% of V_{OUT}) (Note 3)	$V_{O\,RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. $I_{O\,(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

LINFINITY MICROELECTRONICS

APPLICATION NOTES

The LX8383/83A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8383/83A. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a 47µF solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "**RIPPLE REJECTION**"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

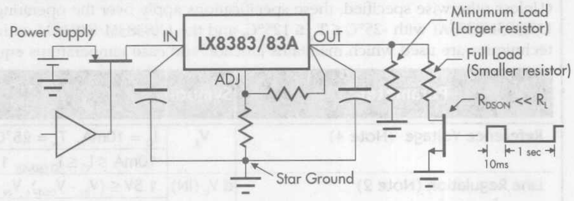


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8383/83A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8383/83A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-to-output voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

APPLICATION NOTES

OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$C = 1 / (6.28 * F_R * R1)$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.
F_R ≡ the ripple frequency in Hz
R1 ≡ the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 = 100Ω:

$C = 1 / (6.28 * 120\text{Hz} * 100\Omega) = 13.3\mu\text{F}$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$M = V_{OUT}/V_{REF}$

where: M ≡ a multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V.

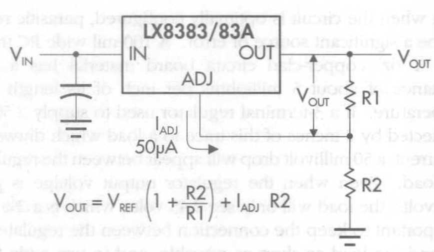
For example, if V_{OUT} = 2.5V the output ripple will be:

$M = 2.5V/1.25V = 2$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

OUTPUT VOLTAGE

The LX8383/83A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.



$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}\ R2$$

FIGURE 2 — BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the LX8383/83A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{Peff} = R_P * \left(\frac{R2+R1}{R1}\right)$$

where: R_P ≡ Actual parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R_{Peff}.

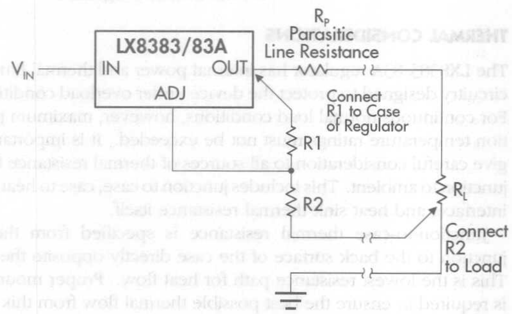


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

LINFINITY MICROELECTRONICS

APPLICATION NOTES

LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below $V_{IN\,(MIN)}$ during transients.

$$V_{IN\,(MIN)} = V_{OUT} + V_{DROPOUT\,(MAX)}$$

where: $V_{IN\,(MIN)}$ ≡ the lowest allowable instantaneous voltage at the input pin.

V_{OUT} ≡ the designed output voltage for the power supply system.

$V_{DROPOUT\,(MAX)}$ ≡ the specified dropout voltage for the installed regulator.

THERMAL CONSIDERATIONS

The LX8383/83A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

Example

Given: $V_{IN} = 5V$
$V_O = 2.8V$, $I_O = 5.0A$
Ambient Temp., $T_A = 50°C$
$R_{\theta JT} = 2.7°C/W$ for TO-220
300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.**

Solution: The junction temperature is:

$$T_J = P_D\,(R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

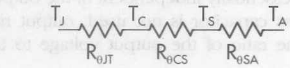
where: P_D ≡ Dissipated power.

$R_{\theta JT}$ ≡ Thermal resistance from the junction to the mounting tab of the package.

$R_{\theta CS}$ ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

$R_{\theta SA}$ ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T_S ≡ Heat sink temperature.



First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\theta SA} = \frac{T_J - T_A}{P_D} - (R_{\theta JT} + R_{\theta CS})$$

$$P_D = (V_{IN(MAX)} - V_O)\,I_O = (5.0V\text{-}2.8V) \cdot 5.0A = 11.0W$$

$$R_{\theta SA} = \frac{125°C - 50°C}{(5.0V\text{-}2.8V) \cdot 5.0A} - (2.7°C/W + 1.0°C/W) = 3.1°C/W$$

Next, select a suitable heat sink. The selected heat sink must have $R_{\theta SA} \leq 3.1°C/W$. Thermalloy heatsink 6296B has $R_{\theta SA} = 3.0°C/W$ with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_J = 11W\,(2.7°C/W + 1.0°C/W + 3.0°C/W) + 50°C = 124°C$$

** Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS

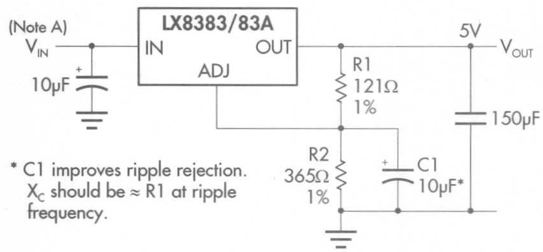


FIGURE 4 — IMPROVING RIPPLE REJECTION

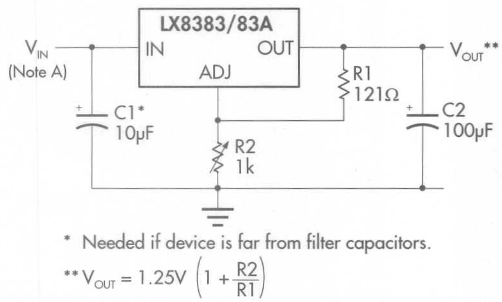


FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

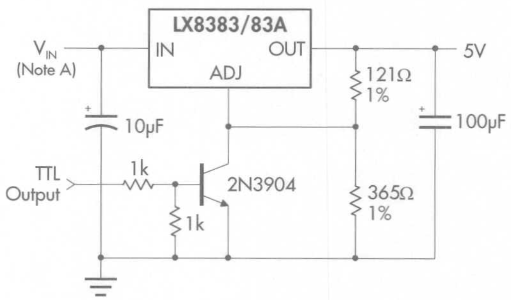


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A: $V_{IN\ (MIN)}$ = (Intended V_{OUT}) + ($V_{DROPOUT\ (MAX)}$)

Notes

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX8384/8384A

5A Low Dropout Positive Adjustable Regulators

PRODUCTION DATA SHEET

DESCRIPTION

The LX8384/84A are positive adjustable regulators designed to provide 5A output current. These regulators yield higher efficiency than currently available devices with all internal circuitry designed to operate down to a 1V input-to-output differential. In each of these products, the dropout voltage is fully specified as a function of load current. **Dropout is guaranteed at a maximum of 1.3V (8384A) and 1.5V (8384)** at maximum output current, decreasing at lower load currents. In addition, on-chip trimming adjusts the reference voltage to 1% maximum at room temperature and **1.5% maximum over the 0 to 125°C range for the LX8384A, making this ideal for the Pentium P54C-VRE specification.**

The LX8384/84A devices are pin-compatible with earlier 3-terminal regulators, such as the 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8384/84A quiescent current flows into the load, thereby increasing efficiency. This feature contrasts with PNP regulators where up to 10% of the output current is wasted as quiescent current. The LX8384I is specified over the industrial temperature range of -25°C to 125°C, and the LX8384C/84AC is specified over the commercial range of 0°C to 125°C.

KEY FEATURES

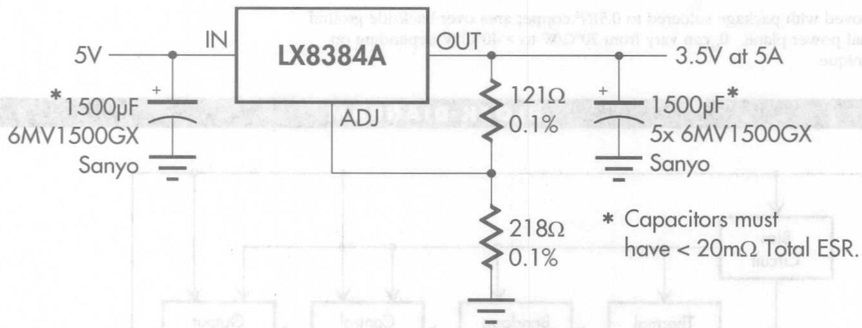
- ■ THREE-TERMINAL ADJUSTABLE
- ■ GUARANTEED < 1.3V HEADROOM AT 5A (LX8384A)
- ■ GUARANTEED 1.5% MAX. REFERENCE (LX8384A)
- ■ OUTPUT CURRENT OF 5A MINIMUM
- □ 0.015% LINE REGULATION
- □ 0.15% LOAD REGULATION

APPLICATIONS

- ■ PENTIUM® PROCESSOR VRE APPLICATIONS
- ■ HIGH EFFICIENCY LINEAR REGULATORS
- ■ POST REGULATORS FOR SWITCHING POWER SUPPLIES
- ■ BATTERY CHARGERS
- ■ CONSTANT CURRENT REGULATORS

PRODUCT HIGHLIGHT

3.5V, 5A REGULATOR



An application of the LX8384A for the Pentium P54C processors meeting VRE specfication.

PACKAGE ORDER INFORMATION

T_A (°C)	Max. Ref. Accuracy	Max. Dropout Voltage	P Plastic TO-220 3-pin	DD Plastic TO-263 3-pin
0 to 125	2%	1.5V	LX8384-00CP	LX8384-00CDD
	1.5%	1.3V	LX8384A-00CP	LX8384A-00CDD
-25 to 125	2%	1.5V	LX8384-00IP	LX8384-00IDD

Note: All surface-mount packages are available in Tape & Reel.
Append the letter "T" to part number. (i.e. LX8384A-00CDDT)

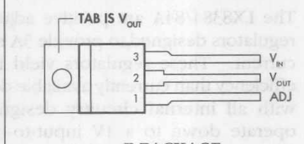
FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

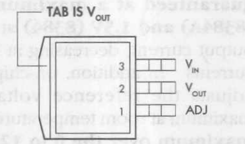
Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
Hermetic (K - Package) .... 150°C
Plastic (DD - Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

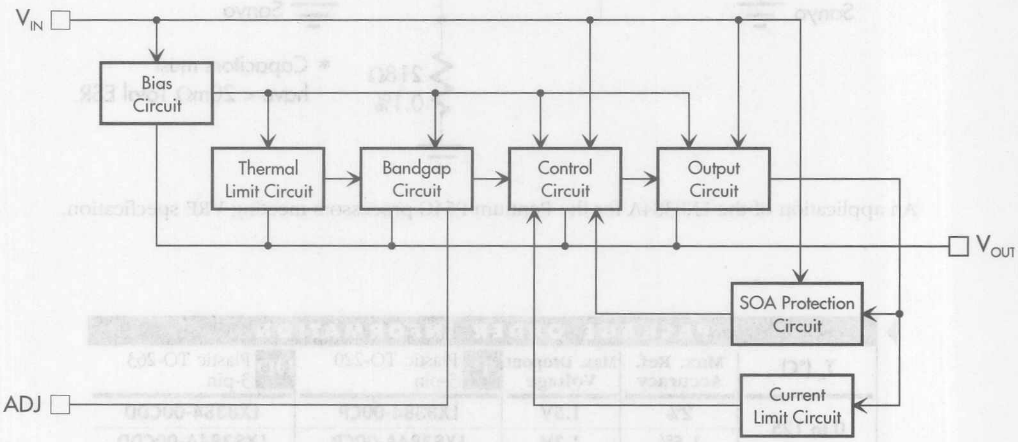
DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W*

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

* θ_{JA} can be improved with package soldered to 0.5IN² copper area over backside ground plane or internal power plane. θ_{JA} can vary from 20°C/W to > 40°C/W depending on mounting technique.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8384C/8384AC with 0°C ≤ T_A ≤ 125°C, and the LX8384I with -25°C ≤ T_A ≤ 125°C; V_{IN} - V_O = 3V; I_O = 5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8384C/84AC/84I Min.	Typ.	Max.	Units
Reference Voltage (Note 4)	V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
		10mA ≤ I_O ≤ 5A, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 10V, P ≤ P_{MAX}	1.225	1.250	1.270	V
Line Regulation (Note 2)	d V_R (IN)	1.3V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 7V, I_O = 10mA		0.015	0.2	%
		1.3V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 10V, I_O = 10mA		0.035	0.3	%
Load Regulation (Note 2)	d V_R (L)	V_O ≥ V_{REF}, V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 5A, T_A = 25°C		0.15	0.5	%
Thermal Regulation (Note 3)	d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		V_O = 5V, f = 120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 6.5V, C_{ADJ} = 10µF, T_A = 25°C, I_O = 5A	65	83		dB
Adjust Pin Current	I_{ADJ}		20	55	100	µA
Adjust Pin Current Change (Note 4)	Δ I_{ADJ}	10mA ≤ I_O ≤ $I_{O(MAX)}$, 1.3V ≤ (V_{IN} - V_O), V_{IN} ≤ 10V		0.2	5	µA
Dropout Voltage LX8384A	Δ V	ΔV_{REF} = 1%, I_O = 5A		1.1	1.3	V
Dropout Voltage LX8384		ΔV_{REF} = 1%, I_O = 5A		1.2	1.5	V
Minimum Load Current	$I_{O(MIN)}$	V_{IN} ≤ 10V		2	10	mA
Maximum Output Current (Note 5)	$I_{O(MAX)}$	V_{IN} - V_O ≤ 7V	5	6		A
		V_{IN} - V_O ≤ 10V	3	4		A
Temperature Stability (Note 3)	d V_O (T)			0.25		%
Long Term Stability (Note 3)	d V_O (t)	T_A = 125°C, 1000 hours		0.3	1	%
RMS Output Noise (% of V_{OUT}) (Note 3)	$V_{O\,RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. $I_{O(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

LINFINITY MICROELECTRONICS

APPLICATION NOTES

The LX8384/84A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8384/84A. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a 47µF solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "**RIPPLE REJECTION**"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

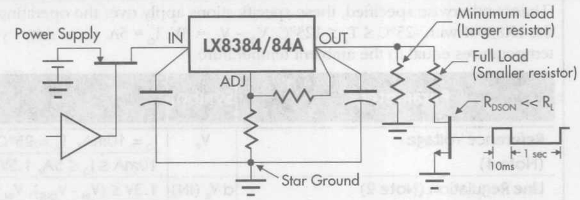


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8384/84A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8384/84A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-to-output voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

LINFINITY MICROELECTRONICS

APPLICATION NOTES

OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency.* The capacitor value can be determined by using this equation:

$C = 1 / (6.28 * F_R * R1)$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.
F_R ≡ the ripple frequency in Hz
R1 ≡ the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 = 100Ω:

$C = 1 / (6.28 * 120Hz * 100\Omega) = 13.3\mu F$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$M = V_{OUT}/V_{REF}$

where: M ≡ a multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V.

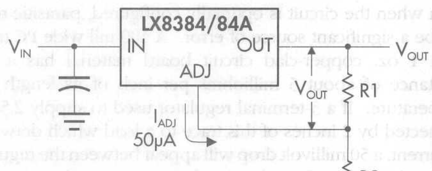
For example, if V_{OUT} = 2.5V the output ripple will be:

$M = 2.5V/1.25V = 2$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

OUTPUT VOLTAGE

The LX8384/84A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.



$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right) + I_{ADJ}\ R2$$

FIGURE 2 — BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the LX8384/84A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load.* This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{Peff} = R_P * \left(\frac{R2+R1}{R1}\right)$$

where: R_P ≡ Actual parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R_{Peff}.

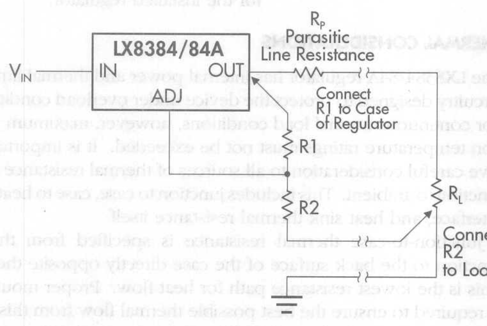


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

APPLICATION NOTES

LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below $V_{IN\,(MIN)}$ during transients.

$$V_{IN\,(MIN)} = V_{OUT} + V_{DROPOUT\,(MAX)}$$

where: $V_{IN\,(MIN)}$ ≡ the lowest allowable instantaneous voltage at the input pin.

V_{OUT} ≡ the designed output voltage for the power supply system.

$V_{DROPOUT\,(MAX)}$ ≡ the specified dropout voltage for the installed regulator.

THERMAL CONSIDERATIONS

The LX8384/84A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

Example

Given: $V_{IN} = 5V$
$V_O = 2.8V$, $I_O = 5.0A$
Ambient Temp., $T_A = 50°C$
$R_{\theta JT} = 2.7°C/W$ for TO-220
300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.**

Solution: The junction temperature is:

$$T_J = P_D\,(R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

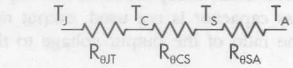
where: P_D ≡ Dissipated power.

$R_{\theta JT}$ ≡ Thermal resistance from the junction to the mounting tab of the package.

$R_{\theta CS}$ ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

$R_{\theta SA}$ ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T_S ≡ Heat sink temperature.



First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\theta SA} = \frac{T_J - T_A}{P_D} - (R_{\theta JT} + R_{\theta CS})$$

$$P_D = (V_{IN(MAX)} - V_O)\,I_O = (5.0V\text{-}2.8V) \cdot 5.0A = 11.0W$$

$$R_{\theta SA} = \frac{125°C - 50°C}{(5.0V\text{-}2.8V) \cdot 5.0A} - (2.7°C/W + 1.0°C/W) = 3.1°C/W$$

Next, select a suitable heat sink. The selected heat sink must have $R_{\theta SA} \leq 3.1°C/W$. Thermalloy heatsink 6296B has $R_{\theta SA} = 3.0°C/W$ with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_J = 11W\,(2.7°C/W + 1.0°C/W + 3.0°C/W) + 50°C = 124°C$$

** Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS

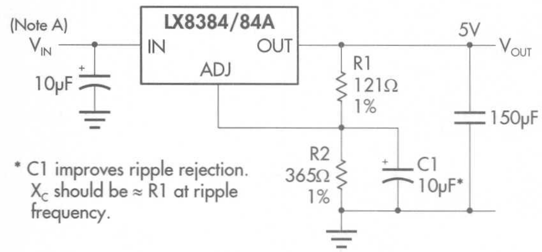


FIGURE 4 — IMPROVING RIPPLE REJECTION

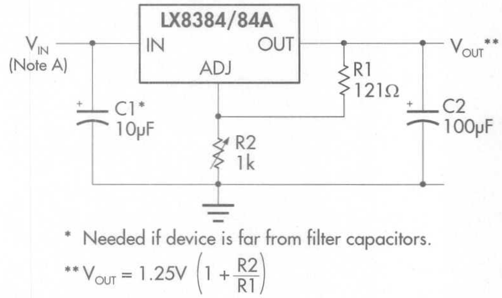


FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

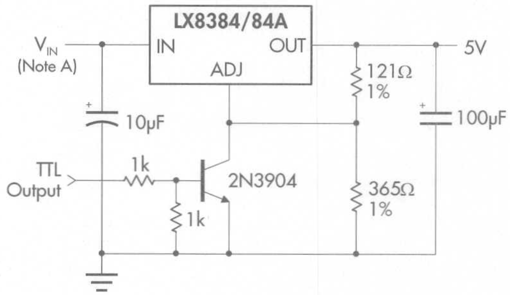


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A: $V_{IN (MIN)}$ = (Intended V_{OUT}) + ($V_{DROPOUT (MAX)}$)

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX8385

3A Low Dropout Positive Adjustable Regulator

PRODUCTION DATA SHEET

DESCRIPTION

The LX8385 is a positive adjustable regulator designed to provide 3A output current. This regulator yields higher efficiency than currently available devices with all internal circuitry designed to operate down to a 1V input to output differential. In this product, the dropout voltage is fully specified as a function of load current. **Dropout is guaranteed at a maximum of 1.5V** at maximum output current, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1%.

The LX8385 device is pin compatible with earlier 3 terminal regulators, such as 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this is generally included in most regulator designs.

The LX8385 quiescent current flows into the load, increasing efficiency. This feature contrasts with PNP regulator designs, where up to 10% of the output current is wasted as quiescent current. The LX8385I for -25°C to +125°C and the LX8385C for 0°C to +125°C.

KEY FEATURES

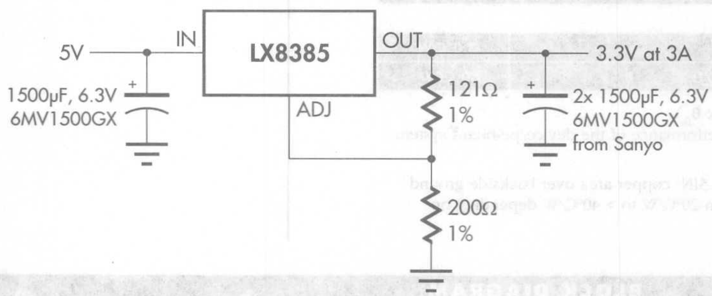
- THREE-TERMINAL ADJUSTABLE
- GUARANTEED < 1.5V HEADROOM AT 3A
- OUTPUT CURRENT OF 3A MINIMUM
- 0.015% LINE REGULATION
- 0.1% LOAD REGULATION

APPLICATIONS

- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

PRODUCT HIGHLIGHT

3.3V, 3A Regulator



PACKAGE ORDER INFORMATION*

T_A (°C)	P Plastic TO-220 3-pin	DD Plastic TO-263 3-pin
0 to 125	LX8385-00CP	LX8385-00CDD
-25 to 125	LX8385-00IP	LX8385-00IDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8385-00CDDT)

* Consult factor for availability of TO-3 Metal Can.

FOR FURTHER INFORMATION CALL (714) 898-8121

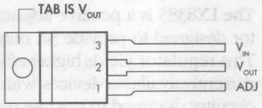
11861 Western Avenue, Garden Grove, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

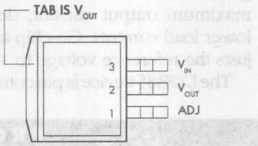
Power Dissipation .... Internally Limited
Input Voltage 20V
Input to Output Voltage Differential 20V
Operating Junction Temperature
  Plastic (P, DD Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

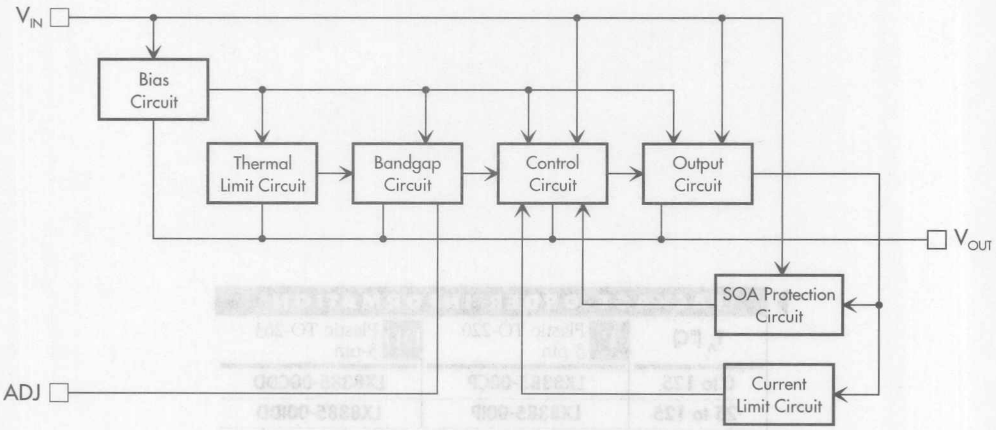
DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W*

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

* θ_{JA} can be improved with package soldered to 0.5IN² copper area over backside ground plane or internal power plane. θ_{JA} can vary from 20°C/W to > 40°C/W depending on mounting technique.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8385C with 0°C ≤ T_A ≤ 125°C, the LX8385I with -25°C ≤ T_A ≤ 125°C; V_{IN} - V_O = 3V; I_O = 3A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8385C/8385I			Units
			Min.	Typ.	Max.	
Reference Voltage (Note 4)	V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
		10mA ≤ I_O ≤ $I_{O(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 20V, P ≤ P_{MAX}	1.225	1.250	1.270	V
Line Regulation (Note 2)	d V_R (IN)	1.5V ≤ (V_{IN} - V_O) ≤ 7V, I_O = 10mA		0.015	0.2	%
		1.5V ≤ (V_{IN} - V_O) ≤ 15V, I_O = 10mA		0.035	0.3	%
Load Regulation (Note 2)	d V_R (L)	V_O ≥ V_{REF}, V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 3A, T_A = 25°C		0.1	0.3	%
		V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 3A		0.2	0.4	%
Thermal Regulation (Note 3)	d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.04	%/W
Ripple Rejection (Note 3)		V_O = 5V, f =120Hz, C_{OUT} = 100μf Tantalum, V_{IN} = 6.5V				
		C_{ADJ} = 10μF, T_A = 25°C, I_O = 3A	65	83		dB
Adjust Pin Current	I_{ADJ}			55	100	μA
Adjust Pin Current Change (Note 4)	Δ I_{ADJ}	10mA ≤ I_O ≤ $I_{O(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 20V		0.2	5	μA
Dropout Voltage	Δ V	ΔV_{REF} = 1%, I_O = 3A		1.2	1.5	V
Minimum Load Current	$I_{O(MIN)}$	V_{IN} ≤ 20V		2	10	mA
Maximum Output Current (Note 5)	$I_{O(MAX)}$	V_{IN} - V_O ≤ 7V	3	3.5		A
		V_{IN} - V_O ≤ 12V	2	2.5		A
		V_{IN} - V_O ≤ 15V	1	2		A
		V_{IN} - V_O ≤ 20V	0.25	1.2		A
Temperature Stability (Note 3)	d V_O (T)			0.25		%
Long Term Stability (Note 3)	d V_O (t)	T_A = 125°C, 1000 hours		0.3	1	%
RMS Output Noise (% of V_{OUT}) (Note 3)	$V_{O\,RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. $I_{O(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

APPLICATION NOTES

The LX8385 is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8385. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

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The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a 47µF solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

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RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

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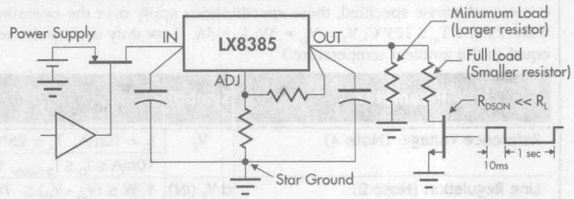


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8385 is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8385 SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-to-output voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

APPLICATION NOTES

OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$C = 1 / (6.28 * F_R * R1)$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.
F_R ≡ the ripple frequency in Hz
R1 ≡ the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 = 100Ω:

$C = 1 / (6.28 * 120Hz * 100\Omega) = 13.3\mu F$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$M = V_{OUT}/V_{REF}$

where: M ≡ a multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V.

For example, if V_{OUT} = 2.5V the output ripple will be:

$M = 2.5V/1.25V = 2$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

OUTPUT VOLTAGE

The LX8385 develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

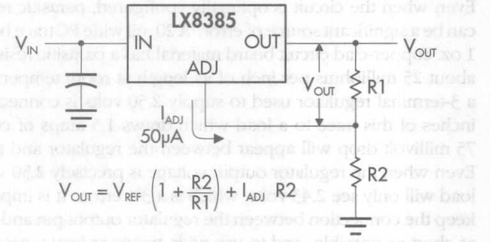


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the LX8385 is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{Peff} = R_P * \left(\frac{R2+R1}{R1}\right)$$

where: R_P ≡ Actual parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R_{Peff}.

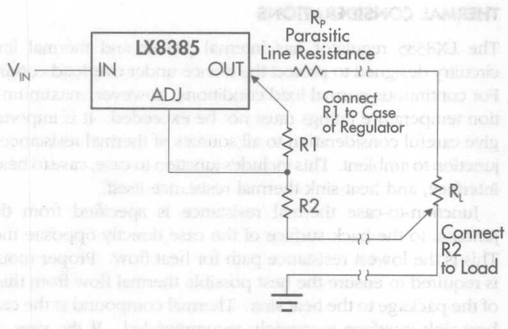


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

APPLICATION NOTES

LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 20 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 25 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 1.5 amps of current, a 75 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.43 volts, which is a 3% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below $V_{IN\,(MIN)}$ during transients.

$$V_{IN\,(MIN)} = V_{OUT} + V_{DROPOUT\,(MAX)}$$

where: $V_{IN\,(MIN)}$ ≡ the lowest allowable instantaneous voltage at the input pin.

V_{OUT} ≡ the designed output voltage for the power supply system.

$V_{DROPOUT\,(MAX)}$ ≡ the specified dropout voltage for the installed regulator.

THERMAL CONSIDERATIONS

The LX8385 regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

Example

Given: $V_{IN} = 5V$

$V_O = 2.5V$, $I_O = 1.5A$

Ambient Temp., $T_A = 50°C$

$R_{\theta JT} = 2.7°C/W$ for TO-220

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.**

Solution: The junction temperature is:

$$T_J = P_D\,(R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

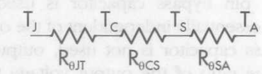
where: P_D ≡ Dissipated power.

$R_{\theta JT}$ ≡ Thermal resistance from the junction to the mounting tab of the package.

$R_{\theta CS}$ ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

$R_{\theta SA}$ ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T_S ≡ Heat sink temperature.



First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\theta SA} = \frac{T_J - T_A}{P_D} - (R_{\theta JT} + R_{\theta CS})$$

$$P_D = (V_{IN(MAX)} - V_O)\,I_O = (5.0V - 2.5V) \bullet 1.5A = 3.75W$$

$$R_{\theta SA} = \frac{125°C - 50°C}{3.75W} - (2.7°C/W + 1.0°C/W)$$

$$= 16.3°C/W$$

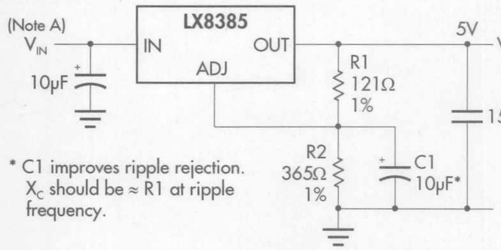
Next, select a suitable heat sink. The selected heat sink must have $R_{\theta SA} \leq 16.3°C/W$. Thermalloy heatsink 6230B has $R_{\theta SA} = 12.0°C/W$.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_J = 3.75W\,(2.7°C/W + 1.0°C/W + 12.0°C/W) + 50°C = 109°C$$

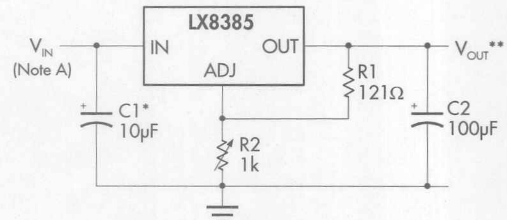
** Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

TYPICAL APPLICATIONS



* C1 improves ripple rejection. X_C should be ≈ R1 at ripple frequency.

FIGURE 4 — IMPROVING RIPPLE REJECTION



* Needed if device is far from filter capacitors.

$$^{**}V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right)$$

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

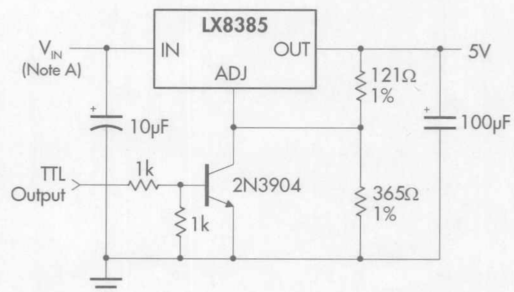


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A: $V_{IN\,(MIN)}$ = (Intended V_{OUT}) + ($V_{DROPOUT\,(MAX)}$)

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX8386

1.5A Low Dropout Positive Adjustable Regulator

PRODUCTION DATA SHEET

DESCRIPTION

The LX8386 is a positive adjustable regulator designed to provide 1.5A output current. This regulator yields higher efficiency than currently available devices with all internal circuitry is designed to operate down to 1V input to output differential. In this product, the dropout voltage is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.5V at maximum output current, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1%.

The LX8386 device is pin compatible with earlier 3 terminal regulators, such as 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8386 quiescent current flows into the load, increasing efficiency. This feature contrasts with PNP regulator, where up to 10% of the output current is wasted as quiescent current. The LX8386I is specified over the full industrial temperature range of -25°C to +125°C and the LX8386C for 0°C to +125°C.

KEY FEATURES

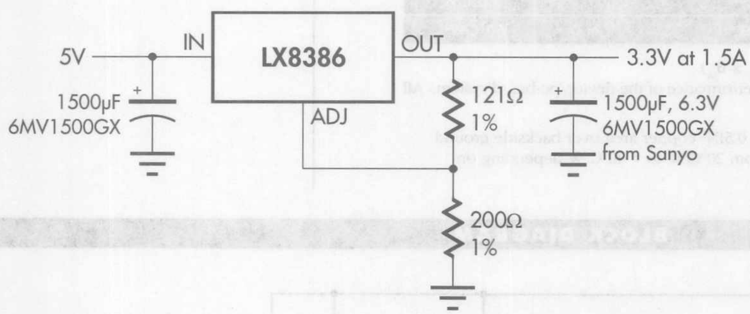
- THREE TERMINAL ADJUSTABLE
- GUARANTEED < 1.5V HEADROOM AT 1.5A
- OUTPUT CURRENT OF 1.5A MINIMUM
- OPERATES DOWN TO 1V DROPOUT
- 0.015% LINE REGULATION
- 0.1% LOAD REGULATION

APPLICATIONS

- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

PRODUCT HIGHLIGHT

3.3V, 1.5A REGULATOR



PACKAGE ORDER INFORMATION

T_A (°C)	P Plastic TO-220 3-pin	DD Surface Mount T0-263
0 to 125	LX8386-00CP	LX8386-00CDD
-25 to 125	LX8386-00IP	LX8386-00IDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8386-00CDDT)

LX8386

1.5A Low Dropout Positive Adjustable Regulator

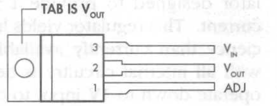
Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

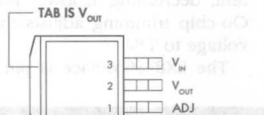
Power Dissipation	Internally Limited
Input Voltage	20V
Input to Output Voltage Differential	20V
Operating Junction Temperature	
Plastic (P, DD Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

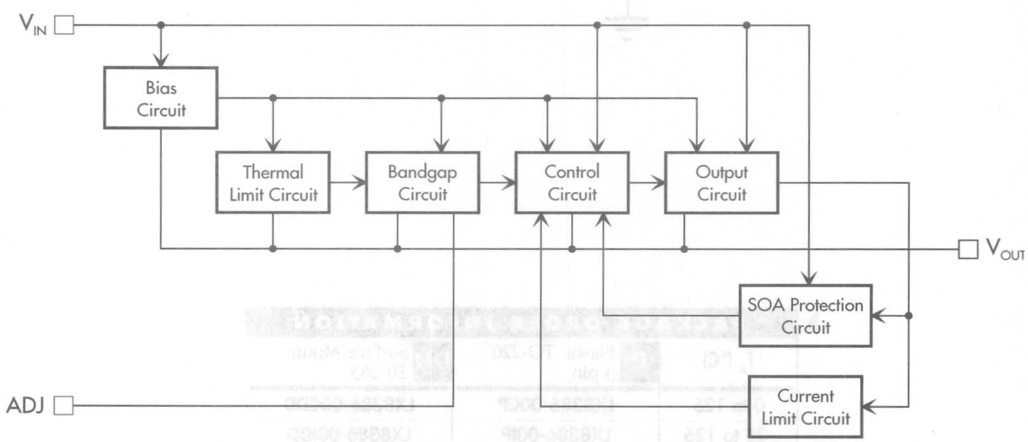
DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W*

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

* θ_{JA} can be improved with package soldered to 0.5IN² copper area over backside ground plane or internal power plane. θ_{JA} can vary from 20°C/W to > 40°C/W depending on mounting technique.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

LX8386

1.5A Low Dropout Positive Adjustable Regulator

Production Data Sheet

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8386C with 0°C ≤ T_A ≤ 125°C, and the LX8386I with -25°C ≤ T_A ≤ 125°C; V_{IN} - V_O = 3V; I_O = 1.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8386C/8386I Min.	LX8386C/8386I Typ.	LX8386C/8386I Max.	Units
Reference Voltage (Note 4)	V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
		10mA ≤ I_O ≤ $I_{O(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 14V, P ≤ P_{MAX}	1.225	1.250	1.270	V
Line Regulation (Note 2)	d V_R (IN)	1.5V ≤ (V_{IN} - V_O) ≤ 7V, I_O = 10mA		0.015	0.2	%
		1.5V ≤ (V_{IN} - V_O) ≤ 14V, I_O = 10mA		0.035	0.3	%
Load Regulation (Note 2)	d V_R (L)	V_O ≥ V_{REF}, V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 1.5A, T_A = 25°C		0.1	0.3	%
		V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 1.5A		0.15	0.4	%
Thermal Regulation (Note 3)	d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.04	%/W
Ripple Rejection (Note 3)		V_O = 5V, f = 120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 6.5V C_{ADJ} = 10µF, T_A = 25°C, I_O = 1.5A	65	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change (Note 4)	Δ I_{ADJ}	10mA ≤ I_O ≤ $I_{O(MAX)}$, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 14V		0.2	5	µA
Dropout Voltage	Δ V	ΔV_{REF} = 1%, I_O = 1.5A		1.2	1.5	V
Minimum Load Current	$I_{O(MIN)}$	V_{IN} ≤ 14V		2	10	mA
Maximum Output Current (Note 5)	$I_{O(MAX)}$	V_{IN} - V_O ≤ 7V	1.5	2.0		A
Temperature Stability (Note 3)	d V_O (T)			0.25		%
Long Term Stability (Note 3)	d V_O (t)	T_A = 125°C, 1000 hours		0.3	1	%
RMS Output Noise (% of V_{OUT}) (Note 3)	$V_{O\,RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. $I_{O(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

LINFINITY MICROELECTRONICS

APPLICATION NOTES

The LX8386 is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8386. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a 47µF solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "**RIPPLE REJECTION**"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

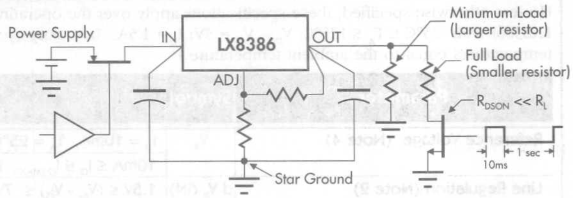


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8386 is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8386 SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-to-output voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

APPLICATION NOTES

OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency.* The capacitor value can be determined by using this equation:

$C = 1 / (6.28 * F_R * R1)$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.
F_R ≡ the ripple frequency in Hz
R1 ≡ the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 = 100Ω:

$C = 1 / (6.28 * 120Hz * 100\Omega) = 13.3\mu F$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$M = V_{OUT}/V_{REF}$

where: M ≡ a multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V.

For example, if V_{OUT} = 2.5V the output ripple will be:

M = 2.5V/1.25V= 2

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

OUTPUT VOLTAGE

The LX8386 develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

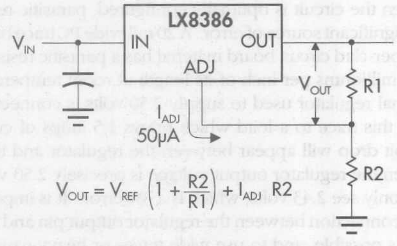


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the LX8386 is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load.* This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{Peff} = R_P * \left(\frac{R2+R1}{R1}\right)$$

where: R_P ≡ Actual parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R_{Peff}.

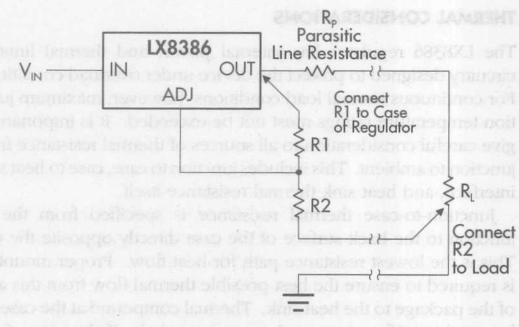


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

APPLICATION NOTES

LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 20 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 25 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 1.5 amps of current, a 75 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.43 volts, which is a 3% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below $V_{IN\,(MIN)}$ during transients.

$$V_{IN\,(MIN)} = V_{OUT} + V_{DROPOUT\,(MAX)}$$

where: $V_{IN\,(MIN)}$ ≡ the lowest allowable instantaneous voltage at the input pin.

V_{OUT} ≡ the designed output voltage for the power supply system.

$V_{DROPOUT\,(MAX)}$ ≡ the specified dropout voltage for the installed regulator.

THERMAL CONSIDERATIONS

The LX8386 regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

Example

Given: $V_{IN} = 5V$

$V_O = 2.5V$, $I_O = 1.5A$

Ambient Temp., $T_A = 50°C$

$R_{\theta JT} = 2.7°C/W$ for TO-220

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.**

Solution: The junction temperature is:

$$T_J = P_D\,(R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

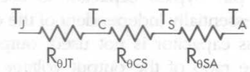
where: P_D ≡ Dissipated power.

$R_{\theta JT}$ ≡ Thermal resistance from the junction to the mounting tab of the package.

$R_{\theta CS}$ ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

$R_{\theta SA}$ ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T_S ≡ Heat sink temperature.



First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\theta SA} = \frac{T_J - T_A}{P_D} - (R_{\theta JT} + R_{\theta CS})$$

$$P_D = (V_{IN(MAX)} - V_O)\,I_O = (5.0V - 2.5V) * 1.5A = 3.75W$$

$$R_{\theta SA} = \frac{125°C - 50°C}{3.75W} - (2.7°C/W + 1.0°C/W) = 16.3°C/W$$

Next, select a suitable heat sink. The selected heat sink must have $R_{\theta SA} \leq 16.3°C/W$. Thermalloy heatsink 6230B has $R_{\theta SA} = 12.0°C/W$.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_J = 3.75W\,(2.7°C/W + 1.0°C/W + 12.0°C/W) + 50°C = 109°C$$

** Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

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TYPICAL APPLICATIONS

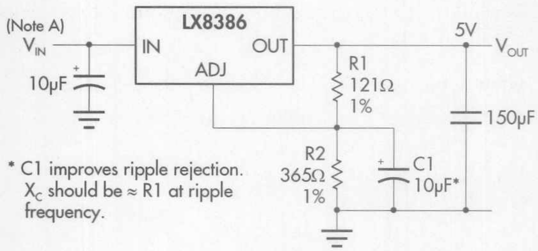


FIGURE 4 — IMPROVING RIPPLE REJECTION

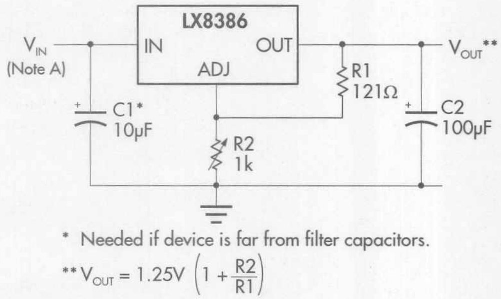


FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

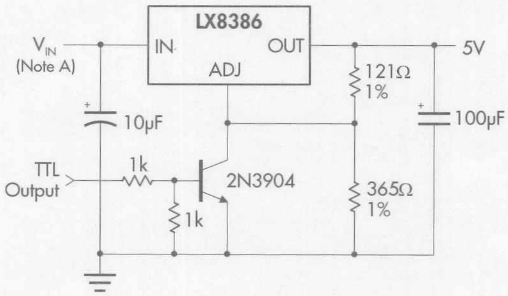


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A: $V_{IN\,(MIN)}$ = (Intended V_{OUT}) + ($V_{DROPOUT\,(MAX)}$)

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX8554

5A EXTREMELY LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8554 is a very low dropout three terminal adjustable regulator with a minimum of 5A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8554 is **guaranteed to have < 1V at 5A dropout voltage** making it ideal to provide well regulated outputs of 2.5V to 3.6V wih input supply as low as 4.75V.

Current limit is trimmed above 5.1A to ensure adequate output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8554 is available in both the through-hole and surface-mount versions of the industry standard 3-pin TO-220 / TO-263 power packages.

The LX8554 is ideal for use in multiple processor applications where output voltage is jumper selected. The LX8554 offers precision output as well as low supply operation (see application below). For higher current applications see the LX8584.

KEY FEATURES

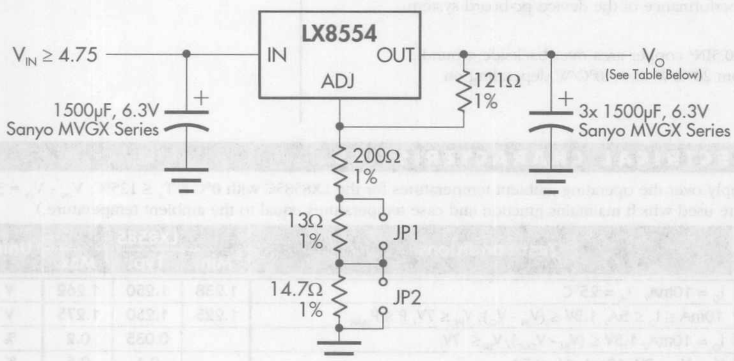
- **GUARANTEED < 1V HEADROOM AT 5A**
- **OUTPUT CURRENT OF 5A MINIMUM**
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT-CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- BATTERY POWERED CIRCUIT
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF THE LX8554 IN A FLEXIBLE MOTHERBOARD WITH OUTPUT VOLTAGE SELECTABLE VIA JUMPERS "JP1" AND "JP2"



JP1	JP2	OUTPUT VOLTAGE
Open	Open	3.6V
Open	Short	3.45V
Short	Short	3.3V

PACKAGE ORDER INFORMATION

T_A (°C)	P Plastic TO-220 3-pin	DD Plastic T0-263 3-pin
0 to 125	LX8554-00CP	LX8554-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8554-00CDDT)

FOR FURTHER INFORMATION CALL (714) 898-8121

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LX8554

5A Extremely Low Dropout Positive Adjustable Regulator

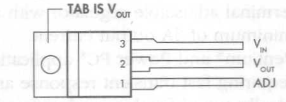
Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

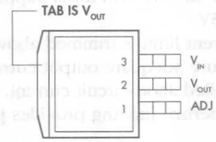
Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
  Plastic (P Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W *

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

* θ_{JA} can be improved with package soldered to 0.5IN² copper area over backside ground plane or internal power plane. θ_{JA} can vary from 20°C/W to > 40°C/W depending on mounting technique.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8585C with 0°C ≤ T_A ≤ 125°C; $V_{IN} - V_O = 3V$; $I_O = 5A$. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8585 Min.	LX8585 Typ.	LX8585 Max.	Units
Reference Voltage	V_R	$I_O = 10mA$, $T_A = 25°C$	1.238	1.250	1.262	V
		$10mA \le I_O \le 5A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$, $P \le P_{MAX}$	1.225	1.250	1.275	V
Line Regulation (Note 2)	dV_R (IN)	$I_O = 10mA$, $1.5V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$		0.035	0.2	%
Load Regulation (Note 2)	dV_R (L)	$V_{IN} - V_O = 3V$, $10mA \le I_O \le 5A$		0.1	0.5	%
Thermal Regulation	dV_O (P)	$T_A = 25°C$, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		$V_O = 3.3V$, f =120Hz, $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$ $C_{ADJ} = 10\mu F$, $T_A = 25°C$, $I_O = 5A$	60	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change	ΔI_{ADJ}	$10mA \le I_O \le 5A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$		0.2	5	µA
Dropout Voltage	ΔV	$\Delta V_{REF} = 1\%$, $I_O = 5A$		0.8	1	V
Minimum Load Current	$I_{O(MIN)}$	$V_{IN} \le 7V$		2	10	mA
Maximum Output Current (Note 4)	$I_{O(MAX)}$	$1.4V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$	5.1	7		A
Temperature Stability (Note 3)	$dV_O(t)$			0.25		%
Long Term Stability (Note 3)	dV_O (t)	$T_A = 125°C$, 1000 hrs			1	%
RMS Output Noise (% of V_O) (Note 3)	$V_{O\,RMS}$	$T_A = 125°C$, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O\,(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

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LX8582A

8.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8582A is a low dropout three terminal adjustable regulator with a minimum of 8.5A output current. Processor applications such as the Cyrix® M1, Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8582A is **guaranteed to have < 1.3V at 8.5A** and is ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 8.6A to ensure adequate output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8582A is available in both the through-hole versions of the industry standard 3-pin TO-220 and TO-247 power packages.

For use in VRE applications, the LX1431 Programmable Reference in conjunction with this regulator offers precision output voltage. See the LX1431 data sheet for information on this product.

KEY FEATURES

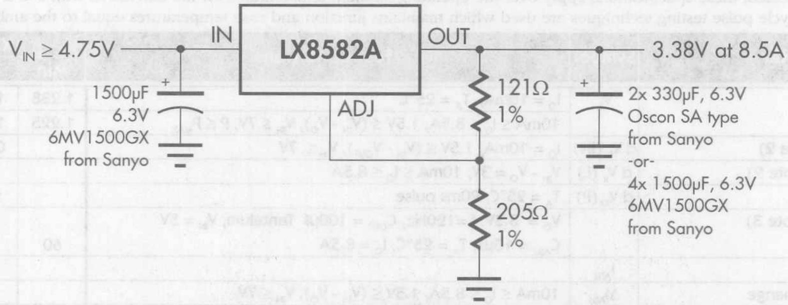
- **GUARANTEED < 1.3V HEADROOM AT 8.5A**
- **OUTPUT CURRENT OF 8.5A MINIMUM**
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- CYRIX M1 APPLICATIONS
- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

CYRIX M1 VOLTAGE SUPPLY
3.38V, 8.5A REGULATOR



Application of the LX8582A for the Cyrix M1 processor family. This circuit is designed to have less than 130mV dynamic response to a 8.5A load transient.

PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal
0 to 125	1.3V	LX8582A-00CP	LX8582A-00CV

FOR FURTHER INFORMATION CALL (714) 898-8121

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LX8582A

8.5A Low Dropout Positive Adjustable Regulator

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation	Internally Limited
Input Voltage	10V
Input to Output Voltage Differential	10V
Operating Junction Temperature	
Plastic (P Package)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

P PACKAGE:

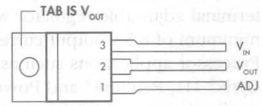
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

V PACKAGE:

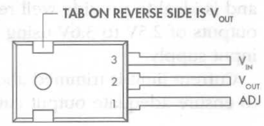
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	35°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



V PACKAGE
(Top View)

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8582AC with $0°C \le T_A \le 125°C$; $V_{IN} - V_O = 3V$; $I_O = 8.5A$. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8582A Min.	LX8582A Typ.	LX8582A Max.	Units
Reference Voltage	V_R	$I_O = 10mA$, $T_A = 25°C$	1.238	1.250	1.262	V
		$10mA \le I_O \le 8.5A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$, $P \le P_{MAX}$	1.225	1.250	1.275	V
Line Regulation (Note 2)	dV_R (IN)	$I_O = 10mA$, $1.5V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$		0.035	0.2	%
Load Regulation (Note 2)	dV_R (L)	$V_{IN} - V_O = 3V$, $10mA \le I_O \le 8.5A$		0.1	0.5	%
Thermal Regulation	dV_O (P)	$T_A = 25°C$, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		$V_O = 3.3V$, f = 120Hz, $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$ $C_{ADJ} = 10\mu F$, $T_A = 25°C$, $I_O = 8.5A$	60	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change	ΔI_{ADJ}	$10mA \le I_O \le 8.5A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$		0.2	5	µA
Dropout Voltage	ΔV	$\Delta V_{REF} = 1\%$, $I_O = 8.5A$		1.1	1.3	V
Minimum Load Current	$I_{O(MIN)}$	$V_{IN} \le 7V$		2	10	mA
Maximum Output Current (Note 4)	$I_{O(MAX)}$	$1.4V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$	8.6	9.2		A
Temperature Stability	dV_O (T)			0.25		%
Long Term Stability	dV_O (t)	$T_A = 125°C$, 1000 hrs			1	%
RMS Output Noise (% of V_O)	$V_{O\,RMS}$	$T_A = 25°C$, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

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LX8584/8584A/8584B

7A Low Dropout Positive Adjustable Regulator

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8584/84A/84B are low dropout three terminal adjustable regulators with a minimum of 7A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8584A is **guaranteed to have < 1.2V at 7A** and the LX8584/84B < **1.4V at 7A dropout voltage,** making them ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply. In addition, **the LX8584B also offers ±1% maximum voltage reference accuracy over temperature**.

Current limit is trimmed above 7.1A to ensure adequate output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8584/84A are available in both the through-hole versions of the industry standard 3-pin TO-220 and TO-247 power packages.

The LX1431 Programmable Reference in conjunction with the LX8584 7A LDO offer precision output voltage (see application below) and are ideal for use in VRE applications.

KEY FEATURES

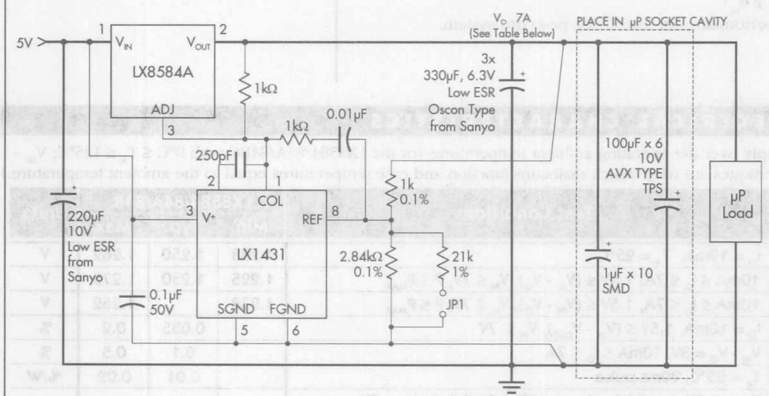
- GUARANTEED 1% VOLTAGE ACCURACY OVER TEMPERATURE (LX8584B)
- GUARANTEED < 1.2V HEADROOM AT 7A (LX8584A)
- GUARANTEED < 1.4V HEADROOM AT 7A (LX8584/84B)
- OUTPUT CURRENT OF 7A MINIMUM
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

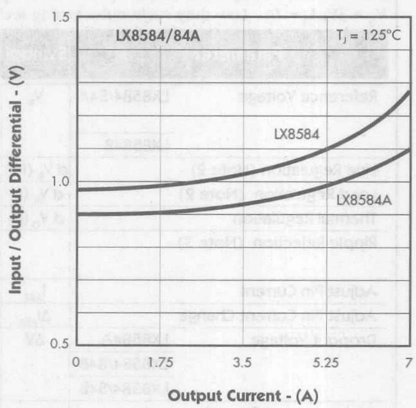
THE APPLICATION OF THE LX8584A & LX1431 IN A 75 & 166MHz P54C PROCESSORS USING 3.3V CACHE



V_O	JP1	TYPICAL APPLICATION
3.50	Short	120/166MHz, VRE, 3.3V Cache
3.38	Open	75/90/100/133MHz, STND, 3.3V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

DROPOUT VOLTAGE VS. OUTPUT CURRENT



PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal
0 to 125	1.4V	LX8584-00CP	LX8584-00CV
		LX8584B-00CP	LX8584B-00CV
	1.2V	LX8584A-00CP	LX8584A-00CV

FOR FURTHER INFORMATION CALL (714) 898-8121

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LX8584/8584A/8584B

7A Low Dropout Positive Adjustable Regulator

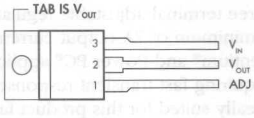
PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

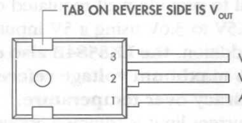
Power Dissipation	Internally Limited
Input Voltage	10V
Input to Output Voltage Differential	10V
Operating Junction Temperature	
Plastic (P Package)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



V PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

V PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	35°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8584/84A/84BC with $0°C \leq T_A \leq 125°C$; $V_{IN} - V_O = 3V$; $I_O = 7A$. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter		Symbol	Test Conditions	LX8584/84A/84B Min.	Typ.	Max.	Units
Reference Voltage	LX8584/84A	V_R	$I_O = 10mA$, $T_A = 25°C$	1.238	1.250	1.262	V
			$10mA \leq I_O \leq 7A$, $1.5V \leq (V_{IN} - V_O)$, $V_{IN} \leq 7V$, $P \leq P_{MAX}$	1.225	1.250	1.275	V
	LX8584B		$10mA \leq I_O \leq 7A$, $1.5V \leq (V_{IN} - V_O)$, $V_{IN} \leq 7V$, $P \leq P_{MAX}$	1.238		1.262	V
Line Regulation (Note 2)		dV_R (IN)	$I_O = 10mA$, $1.5V \leq (V_{IN} - V_{OUT})$, $V_{IN} \leq 7V$		0.035	0.2	%
Load Regulation (Note 2)		dV_R (L)	$V_{IN} - V_O = 3V$, $10mA \leq I_O \leq 7A$		0.1	0.5	%
Thermal Regulation		dV_O (P)	$T_A = 25°C$, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)			$V_O = 3.3V$, f =120Hz, $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$				
			$C_{ADJ} = 10\mu F$, $T_A = 25°C$, $I_O = 7A$	60	83		dB
Adjust Pin Current		I_{ADJ}			55	100	µA
Adjust Pin Current Change		ΔI_{ADJ}	$10mA \leq I_O \leq 7A$, $1.5V \leq (V_{IN} - V_O)$, $V_{IN} \leq 7V$		0.2	5	µA
Dropout Voltage	LX8584A	ΔV	$\Delta V_{REF} = 1\%$, $I_O = 7A$		1.1	1.2	V
	LX8584/84B		$\Delta V_{REF} = 1\%$, $I_O = 7A$		1.2	1.4	V
	LX8584/84B		$\Delta V_{REF} = 1\%$, $I_O = 6A$		1.1	1.3	V
Minimum Load Current		$I_{O(MIN)}$	$V_{IN} \leq 7V$		2	10	mA
Maximum Output Current (Note 4)		$I_{O(MAX)}$	$1.4V \leq (V_{IN} - V_{OUT})$, $V_{IN} \leq 7V$	7.1	8		A
Temperature Stability		dV_O (T)			0.25		%
Long Term Stability		dV_O (t)	$T_A = 125°C$, 1000 hrs			1	%
RMS Output Noise (% of V_O)		$V_{O\,RMS}$	$T_A = 25°C$, $10Hz \leq f \leq 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O\,(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

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LX8585/8585A

4.6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX8585/85A are low dropout three terminal adjustable regulators with a minimum of 4.6A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8585A is **guaranteed to have < 1.2V at 4.6A,** while the LX8585 are specified for 1.4V, making them ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 4.6A to ensure adequate output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8585/85A family is available in both the through-hole and surface-mount versions of the industry standard 3-pin TO-220 / TO-263 power packages.

The LX1431 Programmable Reference and LX8585A offer precision output voltage and are ideal for use in VRE applications (see application below). For higher current applications see the LX8584 data sheet.

KEY FEATURES

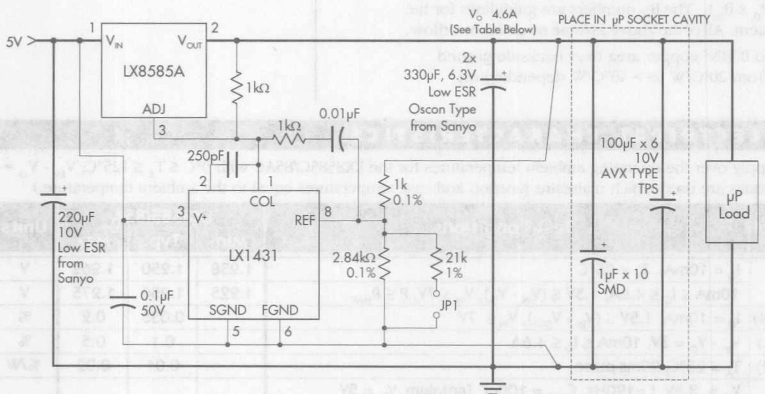
- ■ GUARANTEED < 1.2V HEADROOM AT 4.6A (LX8585A)
- ■ GUARANTEED < 1.4V HEADROOM AT 4.6A (LX8585)
- ■ GUARANTEED < 1.3V HEADROOM AT 3A
- ■ OUTPUT CURRENT OF 4.6A MINIMUM
- □ FAST TRANSIENT RESPONSE
- □ 1% VOLTAGE REFERENCE INITIAL ACCURACY
- □ OUTPUT SHORT CIRCUIT PROTECTION
- □ BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- BATTERY POWERED CIRCUIT
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

THE APPLICATION OF THE LX8585A & LX1431 IN A
75 & 166MHz P54C PROCESSORS USING 5V CACHE



V_O	JP1	TYPICAL APPLICATION
3.50	Short	120/166MHz, VRE, 5V Cache
3.38	Open	75/90/100/133MHz, STND, 5V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	DD Plastic T0-263 3-pin
0 to 125	1.4V	LX8585-00CP	LX8585-00CDD
	1.2V	LX8585A-00CP	LX8585A-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8585A-00CDDT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX8585/8585A

4.6A Low Dropout Positive Adjustable Regulator

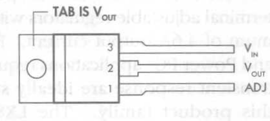
PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

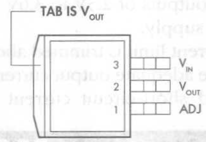
Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
Plastic (P, DD Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W*

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$. The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

* θ_{JA} can be improved with package soldered to 0.5IN² copper area over backside ground plane or internal power plane. θ_{JA} can vary from 20°C/W to > 40°C/W depending on mounting technique.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8585C/85AC with 0°C ≤ T_A ≤ 125°C; $V_{IN} - V_O$ = 3V; I_O = 4.6A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8585/85A Min.	LX8585/85A Typ.	LX8585/85A Max.	Units
Reference Voltage LX8585/85A	V_R	$I_O = 10mA$, $T_A = 25°C$	1.238	1.250	1.262	V
		$10mA \le I_O \le 4.6A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$, $P \le P_{MAX}$	1.225	1.250	1.275	V
Line Regulation (Note 2)	dV_R (IN)	$I_O = 10mA$, $1.5V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$		0.035	0.2	%
Load Regulation (Note 2)	dV_R (L)	$V_{IN} - V_O = 3V$, $10mA \le I_O \le 4.6A$		0.1	0.5	%
Thermal Regulation	dV_O (P)	$T_A = 25°C$, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		V_O = 3.3V, f =120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 5V				
		$C_{ADJ} = 10µF$, $T_A = 25°C$, $I_O = 4.6A$	60	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change	ΔI_{ADJ}	$10mA \le I_O \le 4.6A$, $1.5V \le (V_{IN} - V_O)$, $V_{IN} \le 7V$		0.2	5	µA
Dropout Voltage LX8585A	ΔV	$\Delta V_{REF} = 1\%$, $I_O = 4.6A$		1.1	1.2	V
LX8585		$\Delta V_{REF} = 1\%$, $I_O = 4.6A$		1.2	1.4	V
		$\Delta V_{REF} = 1\%$, $I_O = 3A$		1.1	1.3	V
Minimum Load Current	$I_{O(MIN)}$	$V_{IN} \le 7V$		2	10	mA
Maximum Output Current (Note 4)	$I_{O(MAX)}$	$1.4V \le (V_{IN} - V_{OUT})$, $V_{IN} \le 7V$	4.6	6		A
Temperature Stability (Note 3)	$dV_O(t)$			0.25		%
Long Term Stability (Note 3)	dV_O (t)	$T_A = 125°C$, 1000 hrs		0.3	1	%
RMS Output Noise (% of V_O) (Note 3)	$V_{O\,RMS}$	$T_A = 125°C$, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O\,(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

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LX8586/8586A

6A Low Dropout Positive Adjustable Regulator

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8586/86A are low dropout three terminal adjustable regulators with a minimum of 6A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8586A is **guaranteed to have < 1.1V at 6A** and the LX8586 **< 1.3V at 6A dropout voltage,** making them ideal to provide well-regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 6.1A to ensure adequate output current and controlled short-circuit current.

On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8586/86A are available in both through-hole versions of the industry-standard, 3-pin TO-220 and TO-247 power packages.

Along with the standard µP supply applications, the LX8586 is ideal for Pentium® Pro applications such as GTL+ terminators (see application below).

KEY FEATURES

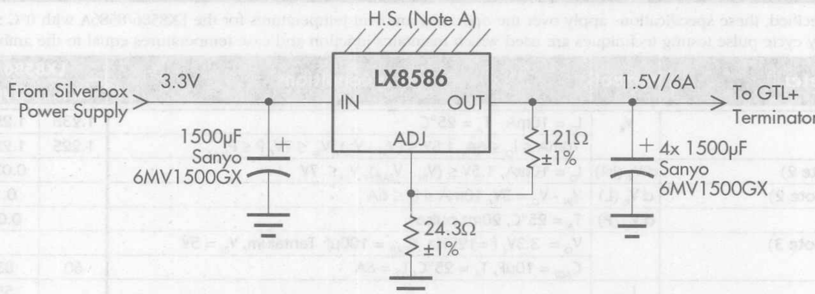
- **GUARANTEED < 1.1V HEADROOM AT 6A (LX8586A)**
- **GUARANTEED < 1.3V HEADROOM AT 6A (LX8586)**
- **OUTPUT CURRENT OF 7A MINIMUM**
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- GTL+ BUS TERMINATORS
- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY

PRODUCT HIGHLIGHT

1.5V, 6A Regulator



Application of LX8586 as 1.5V GTL+ Bus Terminator

Note A: See application note, page 3.

PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal
0 to 125	1.1V	LX8586-00CP	LX8586-00CV
	1.3V	LX8586A-00CP	LX8586A-00CV

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 Western Avenue, Garden Grove, CA. 92841

LX8586/8586A

6A Low Dropout Positive Adjustable Regulator

Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
  Plastic (P Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

P PACKAGE:

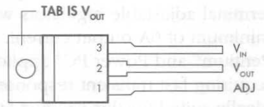
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

V PACKAGE:

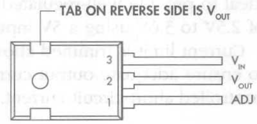
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	35°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



V PACKAGE
(Top View)

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8586/8586A with 0°C ≤ T_A ≤ 125°C; $V_{IN} - V_O$ = 3V; I_O = 6A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter		Symbol	Test Conditions	LX8586/8586A Min.	LX8586/8586A Typ.	LX8586/8586A Max.	Units
Reference Voltage		V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
			10mA ≤ I_O ≤ 6A, 1.5V ≤ ($V_{IN} - V_O$), V_{IN} ≤ 7V, P ≤ P_{MAX}	1.225	1.250	1.275	V
Line Regulation (Note 2)		d V_R (IN)	I_O = 10mA, 1.5V ≤ ($V_{IN} - V_{OUT}$), V_{IN} ≤ 7V		0.035	0.2	%
Load Regulation (Note 2)		d V_R (L)	$V_{IN} - V_O$ = 3V, 10mA ≤ I_O ≤ 6A		0.1	0.5	%
Thermal Regulation		d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)			V_O = 3.3V, f = 120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 5V				
			C_{ADJ} = 10µF, T_A = 25°C, I_O = 6A	60	83		dB
Adjust Pin Current		I_{ADJ}			55	100	µA
Adjust Pin Current Change		ΔI_{ADJ}	10mA ≤ I_O ≤ 7A, 1.5V ≤ ($V_{IN} - V_O$), V_{IN} ≤ 7V		0.2	5	µA
Dropout Voltage	LX8586A	ΔV	ΔV_{REF} = 1%, I_O = 6A		0.9	1.1	V
	LX8586		ΔV_{REF} = 1%, I_O = 6A		1.1	1.3	V
Minimum Load Current		$I_{O(MIN)}$	V_{IN} ≤ 7V		2	10	mA
Maximum Output Current (Note 4)		$I_{O(MAX)}$	1.4V ≤ ($V_{IN} - V_{OUT}$), V_{IN} ≤ 7V	6.1	8		A
Temperature Stability		d V_O (T)			0.25		%
Long Term Stability		d V_O (t)	T_A = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V_O)		$V_{O\,RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O\,(MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

LINFINITY MICROELECTRONICS

APPLICATION NOTES

The LX8586/86A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8586/86A. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a 47µF solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "**RIPPLE REJECTION**"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

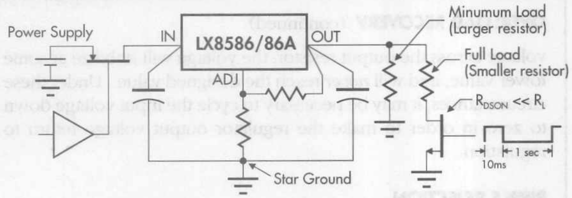


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8586/86A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8586/86A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-to-output voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

APPLICATION NOTES

OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 \bullet F_R \bullet R1)$$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.
F_R ≡ the ripple frequency in Hz
R1 ≡ the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 = 100Ω:

$$C = 1 / (6.28 \bullet 120Hz \bullet 100\Omega) = 13.3\mu F$$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT}/V_{REF}$$

where: M ≡ a multiplier for the ripple seen when the ADJ pin is optimally bypassed.
V_{REF} = 1.25V.

For example, if V_{OUT} = 2.5V the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

OUTPUT VOLTAGE

The LX8586/86A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I_{ADJ} is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

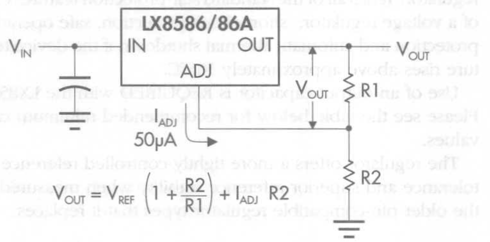


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

LOAD REGULATION

Because the LX8586/86A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{Peff} = R_P \bullet \left(\frac{R2+R1}{R1}\right)$$

where: R_P ≡ Actual parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R_{Peff}.

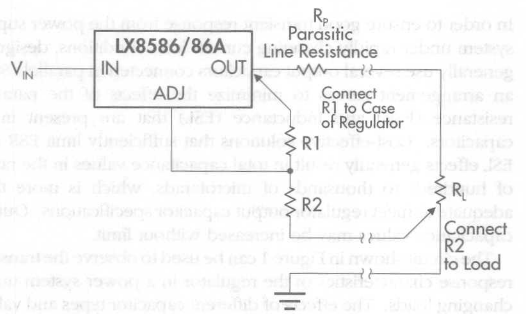


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

APPLICATION NOTES

LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below $V_{IN\,(MIN)}$ during transients.

$$V_{IN\,(MIN)} = V_{OUT} + V_{DROPOUT\,(MAX)}$$

where: $V_{IN\,(MIN)}$ ≡ the lowest allowable instantaneous voltage at the input pin.

V_{OUT} ≡ the designed output voltage for the power supply system.

$V_{DROPOUT\,(MAX)}$ ≡ the specified dropout voltage for the installed regulator.

THERMAL CONSIDERATIONS

The LX8586/86A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

Example

Given: $V_{IN} = 5V$
$V_O = 2.8V$, $I_O = 5.0A$
Ambient Temp., $T_A = 50°C$
$R_{\theta JT} = 2.7°C/W$ for TO-220
300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.**

Solution: The junction temperature is:

$$T_J = P_D\,(R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

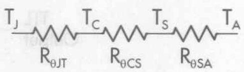
where: P_D ≡ Dissipated power.

$R_{\theta JT}$ ≡ Thermal resistance from the junction to the mounting tab of the package.

$R_{\theta CS}$ ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

$R_{\theta SA}$ ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T_S ≡ Heat sink temperature.



First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\theta SA} = \frac{T_J - T_A}{P_D} - (R_{\theta JT} + R_{\theta CS})$$

$$P_D = (V_{IN(MAX)} - V_O)\,I_O = (5.0V\text{-}2.8V) \cdot 5.0A = 11.0W$$

$$R_{\theta SA} = \frac{125°C - 50°C}{(5.0V\text{-}2.8V) \cdot 5.0A} - (2.7°C/W + 1.0°C/W) = 3.1°C/W$$

Next, select a suitable heat sink. The selected heat sink must have $R_{\theta SA} \leq 3.1°C/W$. Thermalloy heatsink 6296B has $R_{\theta SA} = 3.0°C/W$ with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_J = 11W\,(2.7°C/W + 1.0°C/W + 3.0°C/W) + 50°C = 124°C$$

** Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

TYPICAL APPLICATIONS

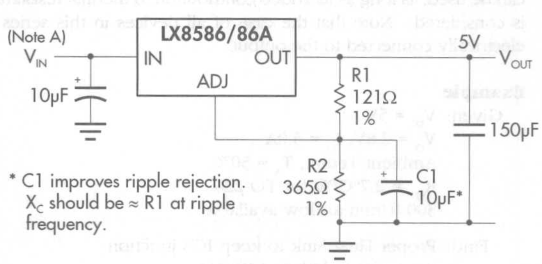
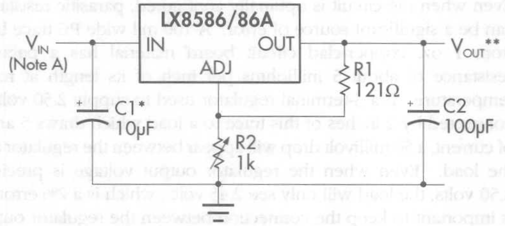


FIGURE 4 — IMPROVING RIPPLE REJECTION



* Needed if device is far from filter capacitors.

$$^{**}V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right)$$

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

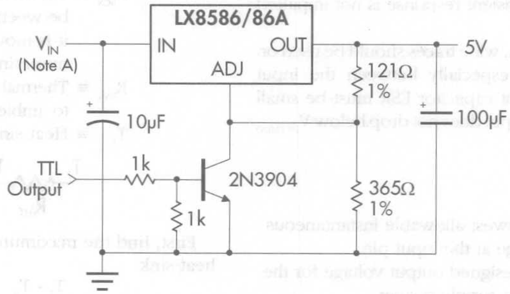


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A: $V_{IN\,(MIN)}$ = (Intended V_{OUT}) + ($V_{DROPOUT\,(MAX)}$)

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LX8587/8587A

3A Low Dropout Positive Adjustable Regulator

PRELIMINARY DATA SHEET

DESCRIPTION

The LX8587/8587A are low dropout three terminal adjustable regulators with a minimum of 3A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8587A is **guaranteed to have < 1.2V dropout at 3A** and the LX8587 < **1.3V at the same current,** making them ideal to provide well-regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 3.1A to ensure adequate output current and controlled short-circuit current. On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8587/87A are available in both through-hole TO-220 as well as TO-263 surface-mount packages.

For higher current applications, see the LX8585 and LX8584 data sheets.

KEY FEATURES

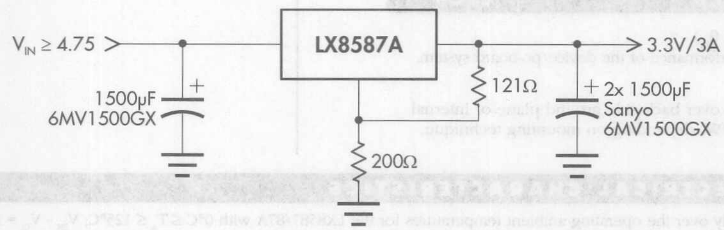
- GUARANTEED < 1.2V HEADROOM AT 3A (LX8587A)
- GUARANTEED < 1.3V HEADROOM AT 3A (LX8587)
- OUTPUT CURRENT OF 3A MINIMUM
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF LX8587 IN A 5V TO 3.3V MOTHERBOARD APPLICATION



The output capacitors must be low ESR and low ESL type for good transient response.

PACKAGE ORDER INFORMATION

T_A (°C)	Dropout Voltage	P Plastic TO-220 3-pin	DD Plastic TO-263 3-pin
0 to 125	1.3V	LX8587-00CP	LX8587-00CDD
	1.2V	LX8587A-00CP	LX8587A-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8587A-00CDDT)

FOR FURTHER INFORMATION CALL (714) 898-8121

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LX8587/8587A

3A Low Dropout Positive Adjustable Regulator

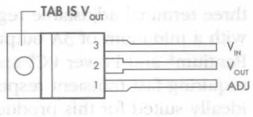
PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

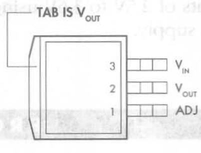
Power Dissipation .... Internally Limited
Input Voltage 10V
Input to Output Voltage Differential 10V
Operating Junction Temperature
  Plastic (P Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W*

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

* With package soldered to 0.5 in.^{2} copper area over back-side ground plane or internal power plane, θ_{JA} can vary from 20°C/W to 40°C/W, depending on mounting technique.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8587/87A with 0°C ≤ T_A ≤ 125°C; $V_{IN} - V_O$ = 3V; I_O = 3A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8587/8587A Min.	LX8587/8587A Typ.	LX8587/8587A Max.	Units
Reference Voltage	V_R	I_O = 10mA, T_A = 25°C	1.238	1.250	1.262	V
		10mA ≤ I_O ≤ 3A, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 7V, P ≤ P_{MAX}	1.225	1.250	1.275	V
Line Regulation (Note 2)	d V_R (IN)	I_O = 10mA, 1.5V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 7V		0.035	0.2	%
Load Regulation (Note 2)	d V_R (L)	V_{IN} - V_O = 3V, 10mA ≤ I_O ≤ 3A		0.1	0.5	%
Thermal Regulation	d V_O (P)	T_A = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		V_O = 3.3V, f =120Hz, C_{OUT} = 100µf Tantalum, V_{IN} = 5V				
		C_{ADJ} = 10µF, T_A = 25°C, I_O = 3A	60	83		dB
Adjust Pin Current	I_{ADJ}			55	100	µA
Adjust Pin Current Change	ΔI_{ADJ}	10mA ≤ I_O ≤ 3A, 1.5V ≤ (V_{IN} - V_O), V_{IN} ≤ 7V		0.2	5	µA
Dropout Voltage	ΔV	ΔV_{REF} = 1%, I_O = 3A (LX8587A)		1	1.2	V
		ΔV_{REF} = 1%, I_O = 3A (LX8587)		1.1	1.3	V
Minimum Load Current	$I_{O(MIN)}$	V_{IN} ≤ 7V		2	10	mA
Maximum Output Current (Note 4)	$I_{O(MAX)}$	1.4V ≤ (V_{IN} - V_{OUT}), V_{IN} ≤ 7V	3.1	5		A
Temperature Stability	d V_O (T)			0.25		%
Long Term Stability	d V_O (t)	T_A = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V_O)	$V_{O\ RMS}$	T_A = 25°C, 10Hz ≤ f ≤ 10kHz		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
Note 3. These parameters, although guaranteed, are not tested in production.
Note 4. $I_{O\ (MAX)}$ is measured under the condition that V_O is forced below its nominal value by 100mV.

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LX8940

5V Low Dropout Regulator

PRODUCTION DATA SHEET

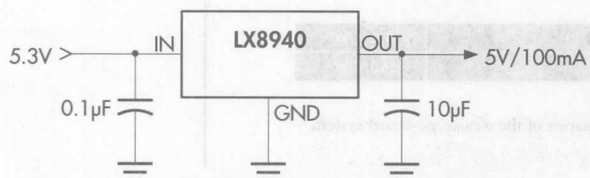
DESCRIPTION

The LX8940 is a 5V, low dropout, low quiescent current regulator rated for 1A of output current. It can regulate with as low as 0.4V headroom between the input and output voltages, thus minimizing power dissipation. In addition, it can be used in applications where worst case supplies require a low input-output differential to maintain regulation. This feature makes it ideal for computer monitors that have to comply with energy-efficient / "Green PC" programs, where the input voltage drops to only a few tenths of a volt above the output when power supply enters sleep-mode operation.

KEY FEATURES

- ■ **2% INTERNALLY TRIMMED OUTPUT**
- ■ **OUTPUT CURRENT IN EXCESS OF 1A**
- ■ **INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.4V AT 1A**
- □ REVERSE BATTERY PROTECTION
- □ 60V LOAD DUMP PROTECTION
- □ -50V REVERSE TRANSIENT PROTECTION
- □ SHORT CIRCUIT PROTECTION
- □ INTERNAL THERMAL OVERLOAD PROTECTION
- □ AVAILABLE IN 3-LEAD PLASTIC TO-220
- □ DROPS IN MOST LM2940 SOCKETS

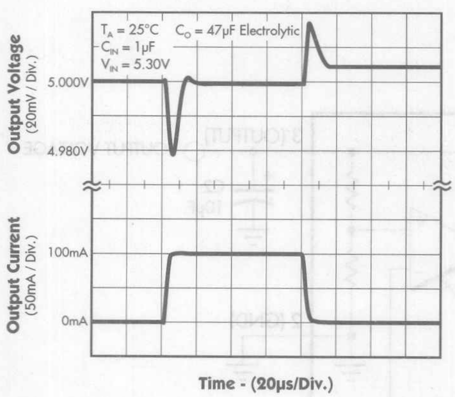
PRODUCT HIGHLIGHT



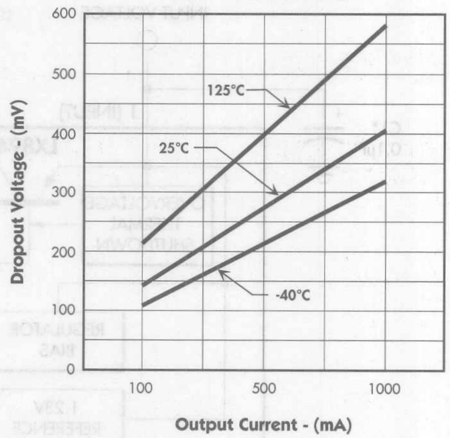
APPLICATIONS

- ■ SMALL HEADROOM BATTERY APPLICATIONS
- ■ HIGH EFFICIENCY LINEAR REGULATORS
- ■ POST REGULATORS FOR SWITCHING POWER SUPPLIES
- ■ GREEN PC MONITOR APPLICATIONS

LOAD TRANSIENT RESPONSE



DROPOUT VOLTAGE VS. OUTPUT CURRENT VS. TEMPERATURE



PACKAGE ORDER INFO

T_A (°C)	P Plastic TO-220 3-pin
0 to 125	LX8940CP
-40 to 125	LX8940IP

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX8940

5V Low Dropout Regulator

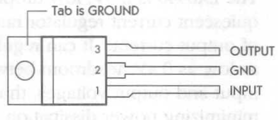
Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage (V_{IN}) .... -15V to 26V
Operating Junction Temperature
  Plastic (P Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

PACKAGE PIN OUTS



P PACKAGE
(Top View)

THERMAL DATA

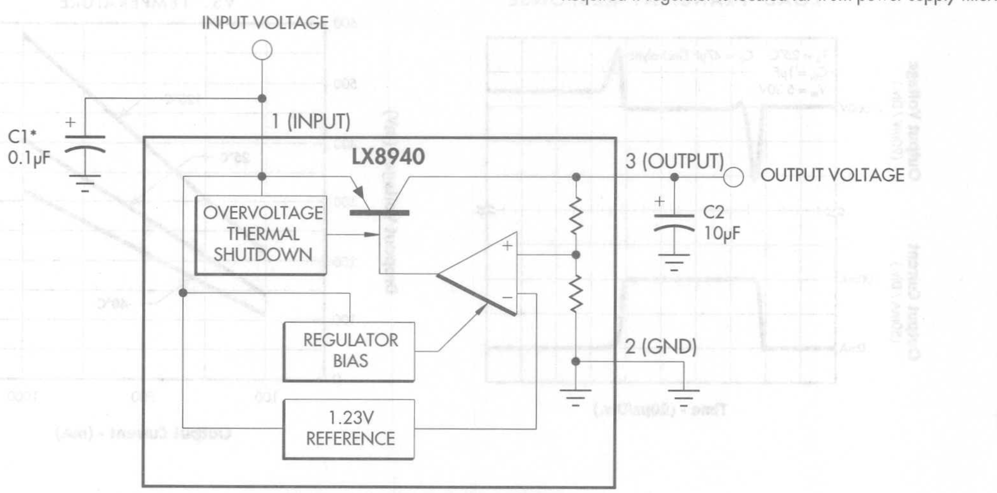
P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM

* Required if regulator is located far from power supply filter.



LINFINITY MICROELECTRONICS

5V Low Dropout Regulator

Production Data Sheet

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Voltage	V_{IN}	Note 2		26	V
Load Current (with adequate heatsinking)		5		1000	mA
Maximum Line Transient (Load Dump), $V_O \leq 5.5V$				60	V
Input Capacitor (V_{IN} to GND)		0.1			µF
Output Capacitor with ESR of 10Ω max., (V_{OUT} to GND & V_{SB} to GND)		10			µF

Note 2. $V_{IN(MIN)} = 1.2\Delta V_{(MAX)}$. See Dropout Voltage maximum limit.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the operating ambient temperatures of -40°C to +125°C for LX8940IP, and 0°C to +125°C for LX8940CP; V_{IN} = 10V, I_O = 1A, C_{OUT} = 22µF, and are for DC characteristics only. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8940 Min.	Typ.	Max.	Units
Output Voltage	V_O	I_O = 0A, T_A = 25°C	4.85	5	5.15	V
Line Regulation	ΔV_{OI}	$7V \leq V_{IN} \leq 26V$, I_O = 5mA		10	50	mV
Load Regulation	ΔV_{OL}	$50mA \leq I_O \leq 1A$		10	50	mV
Output Impedance (Note 3)	r_O	$100mA_{DC}$ and $20mA_{RMS}$, f_O = 120Hz		200		mΩ
Quiescent Current	I_Q	$I_O \leq 5mA$, $7 \leq V_{IN} \leq 26V$		3	15	mA
		I_O = 500mA		30	50	mA
		I_O = 1000mA		115	180	mA
Output Noise Voltage (Note 3)	$V_{O\ RMS}$	10Hz - 100kHz, I_O = 5mA		150		μV_{RMS}
Long Term Stability (Note 3)				20		mV/1000hr
Ripple Rejection (Note 3)	R_R	f_O = 120Hz, $1V_{RMS}$, I_O = 100mA		66		dB
Dropout Voltage	ΔV	I_O = 100mA		150	300	mV
		I_O = 500mA		275	500	mV
		I_O = 1A		400	800	mV
Current Limit	I_{CL}	V_{IN} = 26V	1	1.2		A
Maximum Operational Input Voltage	$V_{IN\ (MAX)}$		26	31		V
Maximum Line Transient	$V_{IN\ (TR)}$	R_O = 100Ω, T ≤ 100ms		60		V

Note 3. These parameters, although guaranteed, are not tested in production.

LINFINITY MICROELECTRONICS

APPLICATION NOTES

The advantages of using a low-dropout regulator such as the LX8940 is the need for less "headroom" for full regulation, and the inherent reverse polarity protection provided by the PNP output device. A typical NPN regulator design requires an input to output differential of approximately two volts minimum. This is due to the 2Vbe + Vcesat of the NPN Darlington used in the output, coupled with the voltage drop across the current limit resistor. In contrast, the "PNP Regulator" uses a single series pass transistor with its single Vcesat, thus the lower input to output voltage differential or dropout voltage.

In some applications the regulator output voltage is used not only as a power supply but also as a voltage reference for control systems. In such cases not just the temperature stability of the output is important but also the initial accuracy. LX8940 fills this need as the internal bandgap reference is trimmed allowing a typical output voltage tolerance of ±1%.

EXTERNAL CAPACITORS

To stabilize the outputs and prevent oscillation (perhaps by many volts) external capacitors are required. The minimum recommended value for the output capacitors is 10µF, although the actual size and type will likely vary according to the particular application, e.g., operating temperature range and load. Another consideration is the effective series resistance (ESR) of the capacitor. Capacitor ESR will vary by manufacturer. Consequently, some evaluation may be required to determine the minimum value of the output capacitors. Generally worst case occurs at the maximum load and minimum ambient temperature.

The size of the output capacitor can be increased to any value above the minimum. One possible advantage of this would be to maintain the output voltage during brief periods of negative input transients

The output capacitors chosen should be rated for the full range of ambient temperature over which the circuit will be exposed and expected to operate. For example, many aluminum type electrolytic capacitors change values at cold temperatures. The effective capacitance is reduced and regulator stability is effected. Tantalum capacitors are a good choice for these types of environments.

OUTPUT PROTECTION

The output features fault protection against overvoltage as well as a thermal shutdown feature. If the input voltage rises above 33V (load dump), the output shuts down automatically. The internal circuitry is thus protected and the IC is able to survive higher voltage transients than might otherwise be expected. The thermal shutdown output effectively guards against overheating of the die and protects the device from being damaged.

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LX8941

ADJUSTABLE LOW DROPOUT REGULATOR

PRELIMINARY DATA SHEET

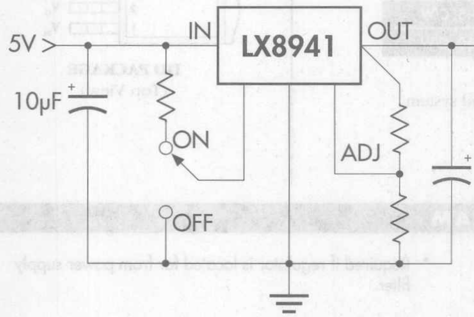
DESCRIPTION

The LX8941 is an adjustable, low dropout regulator rated for more than 1A of output current. It can regulate with as low as 0.6V headroom between the input and output voltages, at 1A output current, thus minimizing power dissipation. In addition, it can be used in applications where worst case supplies require a low input-output differential to maintain regulation. This feature makes it ideal for some processor applications that require 4V operation from a 5V supply. In addition, the LX8941 provides an on/off switch that reduces the IC quiescent current when activated, making it ideal for battery operated applications.

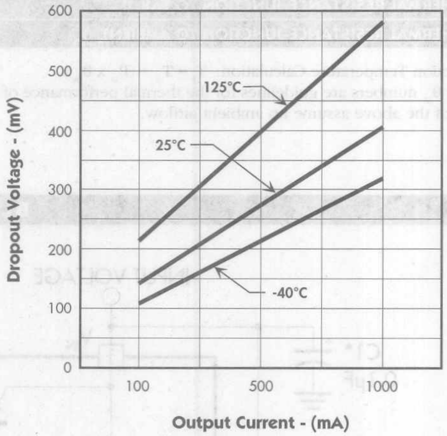
KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- OUTPUT CURRENT IN EXCESS OF 1A
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 1A
- REVERSE BATTERY PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- AVAILABLE IN 5-LEAD PLASTIC TO-220 AND SURFACE MOUNT TO-263

PRODUCT HIGHLIGHT



DROPOUT VOLTAGE VS. OUTPUT CURRENT VS. TEMPERATURE



PACKAGE ORDER INFORMATION

T_A (°C)	P Plastic TO-220 5-pin	DD Plastic TO-263 5-pin
0 to 70	LX8941CP	LX8941CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8941CDDT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX8941

Adjustable Low Dropout Regulator

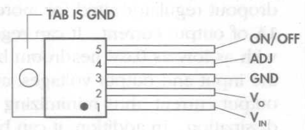
Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

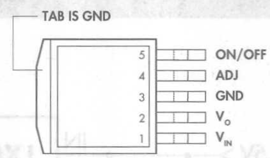
Input Voltage (V_{IN}) 24V
Operating Junction Temperature
Plastic (P, DD Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)



DD PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	4.5°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

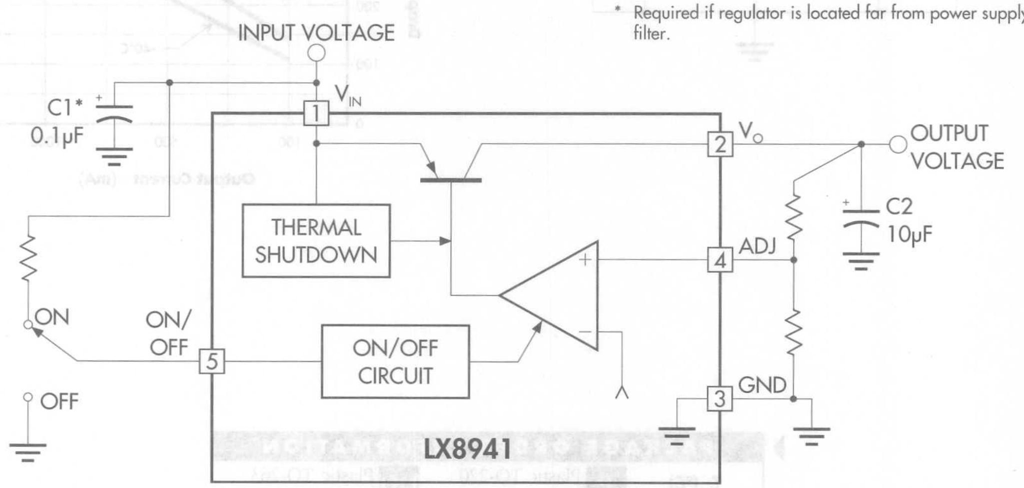
DD PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	4.5°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM

* Required if regulator is located far from power supply filter.



LINFINITY MICROELECTRONICS

PRELIMINARY DATA SHEET

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Voltage	V_{IN}	Note 2		24	V
Load Current (with adequate heatsinking)		5		1000	mA
Input Capacitor (V_{IN} to GND)		0.1			µF
Output Capacitor with ESR of 10Ω max., (V_{OUT} to GND)		10			µF

Note 2. $V_{IN(MIN)} = 1.2\Delta V_{(MAX)}$. See Dropout Voltage maximum limit.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the operating ambient temperature of 0°C to +125°C for LX8941CP; V_{IN} = 10V, I_O = 1A, C_{OUT} = 22µF, and are for DC characteristics only. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8941 Min.	Typ.	Max.	Units
ADJ Pin Voltage	V_O	I_O = 0A, T_A = 25°C	1.231	1.27	1.308	V
Line Regulation	ΔV_{OI}	$V_O + 2V \le V_{IN} \le 26V$, I_O = 5mA		10	50	mV
Load Regulation	ΔV_{OL}	$50mA \le I_O \le 1A$		10	50	mV
Dropout Voltage	ΔV	I_O = 100mA		150	300	mV
		I_O = 500mA		275	500	mV
		I_O = 1A		400	800	mV
Quiescent Current	I_Q	$I_O \le 5mA$, $7 \le V_{IN} \le 26V$		3	15	mA
		I_O = 500mA		30	50	mA
		I_O = 1000mA		115	180	mA
Current Limit	I_{CL}	V_{IN} = 26V	1	1.2		A
Output Noise Voltage (Note 3)	$V_{O\,RMS}$	10Hz - 100kHz, I_O = 5mA		150		μV_{RMS}
Long Term Stability (Note 3)				20		mV/1000hr
Ripple Rejection (Note 3)	R_R	f_O = 120Hz, $1V_{RMS}$, I_O = 100mA		66		dB
Enable Logic Section						
On Threshold Voltage			2			V
On Threshold Current					50	µA
Off Threshold Voltage					0.8	V
Off Threshold Current			-10			µA

Note 3. These parameters, although guaranteed, are not tested in production.

LINFINITY MICROELECTRONICS

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1590/LXM1591

CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

LXM1590 series CCFL (cold cathode fluorescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in portable computers where dimmability, ultrahigh efficiency, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Mechanical form factors and electrical characteristics can be customized for volume applications. Both monochrome and color displays with either one or two lamps are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its *single* stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one or two pairs of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

Two module versions are available. The half bridge LXM1590 provides peak efficiency when operated with less than 2 watt lamps at input voltages above 6 volts. The LXM1591 achieves higher efficiency at higher output power levels and lower input voltages with its full bridge drive circuit.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

KEY FEATURES

- 35% MORE LIGHT OUTPUT AT 2.5 WATTS
- CLOSED LOOP, FULLY REGULATING DESIGN
- 4.5V TO 30V INPUT VOLTAGE RANGES
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

APPLICATIONS

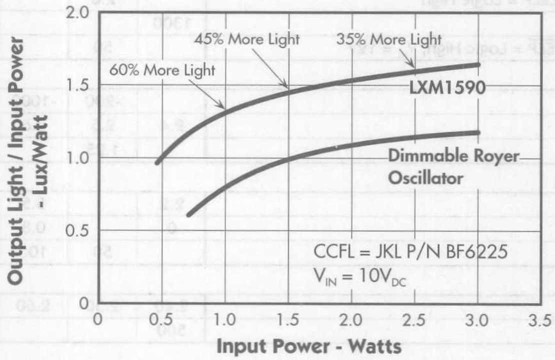
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD ENCLOSURES
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

PRODUCT HIGHLIGHT

MEASURED LIGHT OUTPUT VS. POWER INPUT FOR LXM1590 AND A POPULAR ROYER OSCILLATOR INVERTER WITH DIMMING CONTROL



MODULE ORDER INFORMATION

HALF BRIDGE DRIVE	FULL BRIDGE DRIVE
LXM1590-xxxxx-zz	LXM1591-xxxxx-zz

See instructions inside for completing module part number.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LXM1590/LXM1591

CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... LXM1590 = -0.3V to 30V/ LXM1591 = -0.3 to 7.0V
Output Voltage, no load .... Internally Limited to $1900V_{RMS}$
Output Current .... $8.0mA_{RMS}$ (Internally Limited)
Output Power 4.2W
Input Signal Voltage, (SLEEP and BRITE Inputs) .... -0.3V to 6.5V
Ambient Operating Temperature, zero airflow .... 0°C to 60°C
Storage Temperature Range .... -40°C to 85°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

*This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the '**R.C.**' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.*

Parameter		Symbol	Recommended Operating Conditions			Units
			Min.	R.C.	Max.	
Input Supply Voltage	LXM1590	V_{IN}	7	12	30	V
	LXM1591		4.5		6.5	V
Output Power		P_O		2.5	4.0	W
Brightness Control Input Voltage Range		V_{BRITE}	0.8		2.5	V
Lamp Operating Voltage		V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness		I_{OLAMP}		5	7	mA_{RMS}
Operating Ambient Temperature Range		T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1590/1591.

Parameter	Symbol	Test Conditions	LXM1590/1591 Min.	Typ.	Max.	Units
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L\,(MAX)}$	$V_{BRITE} = 2.5\,V_{DC}$, $\overline{SLEEP}$ = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	$I_{L\,(MIN)}$	$V_{BRITE} = 0.9\,V_{DC}$, $\overline{SLEEP}$ = Logic High		2.6		mA_{RMS}
Lamp Start Voltage	V_{LS}	$0°C < T_A < 60°C$	1300			V_{RMS}
Operating Frequency	f_O	$V_{BRITE} = 2.5V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 12V$		50		KHz
Brightness Control						
Input Current	I_{BRITE}	$V_{BRITE} = 0V_{DC}$		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O\,(LAMP)} = 100\%$	2.4	2.5	2.6	V_{DC}
Input Voltage for 50% Lamp Current	V_C	$I_{O\,(LAMP)} = 50\%$		1.25		V_{DC}
$\overline{SLEEP}$ Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}} = 0 - 5V_{DC}$		50	100	μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	$0 < I_{REF} < 500\mu A$	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		500			μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN\,(MIN)}$	$V_{IN} = 5V_{DC}$, $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	LXM1590, $V_{IN} = 12V_{DC}$, $I_{O\,(LAMP)} = 5mA_{RMS}$		92		%
		LXM1591, $V_{IN} = 5V_{DC}$, $I_{O\,(LAMP)} = 5mA_{RMS}$		90		%

LINFINITY MICROELECTRONICS

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+7 to +30V_{DC})
CN1-3 CN1-4	GND	Power supply return.
CN1-5	$\overline{\text{SLEEP}}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{\text{SLEEP}}$ through a 33kΩ resistor to V_{IN} or directly to any voltage between 2.5 and 7V. May be used to modulate lamp intensity by varying duty cycle.
CN1-6	BRITE	Brightness control input. Apply 0.9 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. Open circuit or 2.5V gives maximum brightness.
CN1-7	AGND	Brightness control signal return. For best results do not run V_{IN} power supply current return through this pin.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.
CN2-2	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.

CCFL INVERTER EFFICIENCY - THE EVOLUTION CONTINUES

Portable computing is dependent on low power flat panel LCD display technology. Each new shrinking of computer size and weight has resulted in exponential market growth. New LCD's with richer color now promise yet another order of magnitude growth in notebook sized machines. Great looking color displays need lots of light, more than monochrome displays. The power to generate that light must come from the system battery. But the battery cannot grow in size and weight, so the conversion from battery power to visible light must be made more efficient.

The LXM1590/1591 modules are the latest evolution in inverter technology and represent the most efficient method yet, generating 35% to 60% more light from a CCFL tube than today's most popular solutions[1]. Present technologies are based on the venerable Royer oscillator circuit enhanced with various types of voltage regulator circuits that permit operation from an unregulated battery input and enable the dimming function needed in portable computers. Figures 1 and 2 below characterize relative efficiency over a broad range of input voltage and at typical one and two lamp CCFL output power levels. Figure 3 compares actual light outputs of the LXM1591 module at various battery power levels with a popular dimmable Royer oscillator based solution. The data in Figure 3 was measured in a specially built and carefully calibrated fixture using the same physical CCFL tube for both circuits. Lamp current and voltage of the test CCFL is typical of single tube notebook display applications. The actual amount of light output from the lamp you are using may differ from this curve, but the relative increase in performance over the Royer based circuit will remain.

FIGURE 1. — RELATIVE EFFICIENCY vs. V_{IN} FOR THE LXM1590

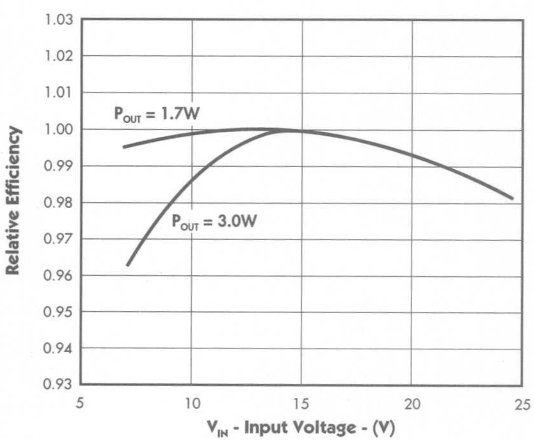


FIGURE 2. — RELATIVE EFFICIENCY vs. V_{IN} FOR THE LXM1591

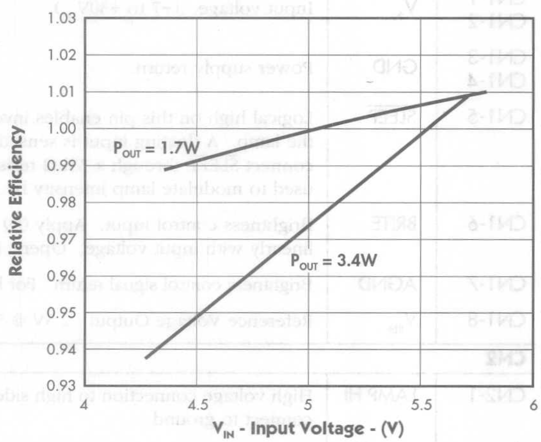
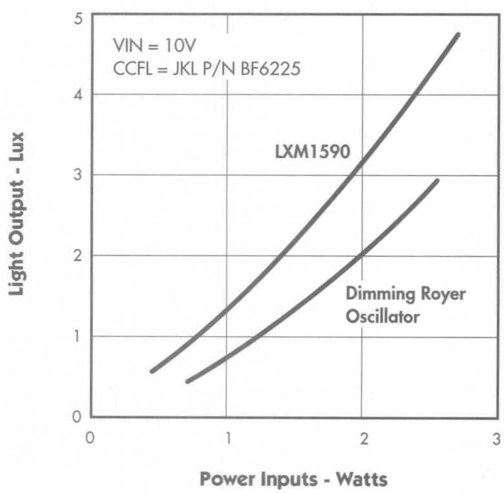


FIGURE 3. — LIGHT OUTPUT vs. POWER INPUT



Note: 1 Lux = 1 Lm/m² = 1 Lumen/meter² = 10.76 foot candles.

[1] See "A New and Improved Control Technique Greatly Simplifies The Design Of Highly Efficient Dimming CCFL Backlight Inverter Circuits". *Nalbant, LMI, 1994*

TYPICAL APPLICATIONS

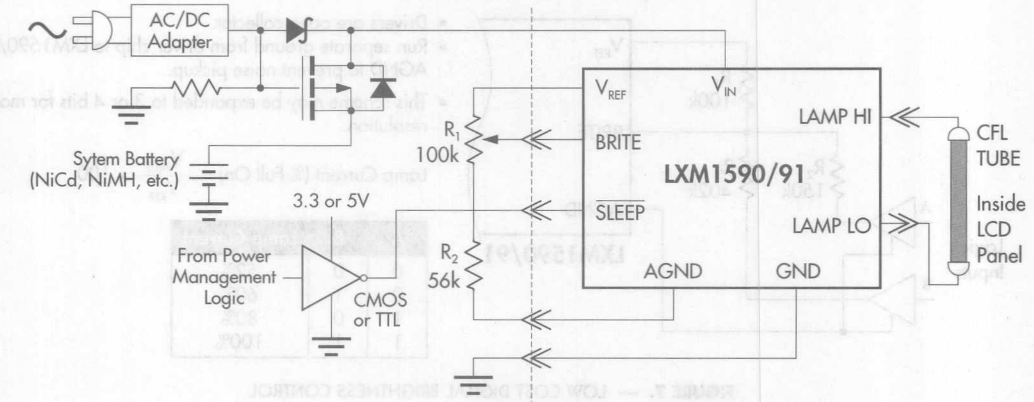
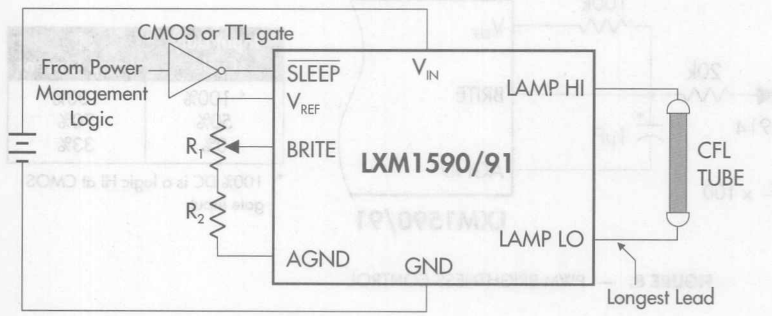


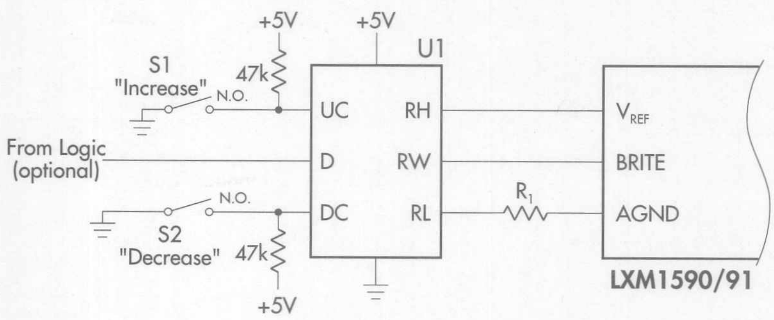
FIGURE 4. — NOTEBOOK SYSTEM APPLICATION



$$\text{Lamp Current (\%)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

R_1 = 100k typical, 5k minimum
R_2 = Value optional to determine lowest brightness setting
R_2 = 0.5 R_1 minimum

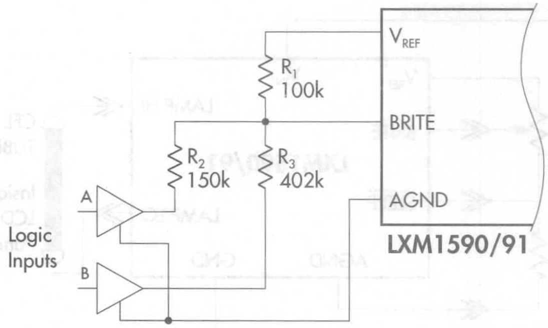
FIGURE 5. — POTENTIOMETER BRIGHTNESS CONTROL & SLEEP MODE



- S1 & S2 are momentary push buttons, normally open contacts.
- U1 = Dallas Semiconductor DS1669-100, 100k digital pot.
- R_1 value optional for choosing dimming range:
  for R_1 = 100k, Range = 100% to 50%
  for R_1 = 50k, Range = 100% to 33%
- R_1 minimum value is 0.5 R_{POT}.

FIGURE 6. — NON-VOLATILE DIGITAL BRIGHTNESS CONTROL

TYPICAL APPLICATIONS (continued)

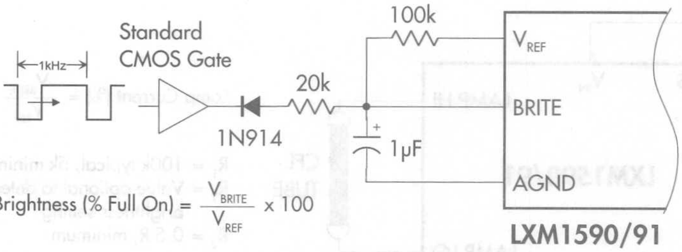


- Drivers are open collector.
- Run separate ground from driver chip to LXM1590/91 AGND to prevent noise pickup.
- This scheme may be expanded to 3 or 4 bits for more resolution.

$$\text{Lamp Current (\% Full On)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

A	B	Lamp Current
0	0	52%
0	1	60%
1	0	80%
1	1	100%

FIGURE 7. — LOW COST DIGITAL BRIGHTNESS CONTROL



$$\text{Brightness (\% Full On)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

Input Duty Cycle	Lamp Current
* 100%	100%
50%	70%
0%	33%

* 100% DC is a logic HI at CMOS gate input.

FIGURE 8. — PWM BRIGHTNESS CONTROL

LINFINITY MICROELECTRONICS

COMPLETING THE MODULE PART NUMBER

1. Choose either the half or full bridge version by comparing your operating conditions and efficiency needs to the efficiency curves in Figures 1 & 2.
2. Choose the nominal input voltage you will be using, that is, the voltage where you want efficiency to be highest. Selections are in 1.2V increments to match the 1.2V/cell potential of NiCd and NiMH batteries. If a different type of power source is being used, select the closest nominal voltage.
3. Choose the minimum input voltage where full lamp brightness is needed. For convenience, selections are in 0.9V increments, corresponding to end of discharge potential for NiCd and NiMH cells. Your selection need not correspond to the number of cells selected for nominal voltage input.
4. Specify lamp running voltage.
5. Specify maximum lamp start voltage.
6. Specify lamp running current.
7. Choose over temperature option. (See "Over Temperature Protection Option" Section on Page 3 for complete description of this option.)
8. Choose mechanical configuration (-zz) from the specific mechanical data sheets below.

LXM159□ - □□□□□R - □□

X - X X X X X X - Z Z

Module Type

0 = Half Bridge Drive (7.0V to 30V Battery Voltage)
1 = Full Bridge Drive (4.5V to 6.5V Battery Voltage)

Nominal Input Voltage (4 thru 11 NiMH cells)

1 = 4.8 V_{DC}	5 = 9.6 V_{DC}	9 = RSVD *
2 = 6.0 V_{DC}	6 = 10.8 V_{DC}	0 = RSVD *
3 = 7.2 V_{DC}	7 = 12.0 V_{DC}	
4 = 8.4 V_{DC}	8 = 13.2 V_{DC}	

Minimum Input Voltage

1 = 4.5 V_{DC}	5 = 8.1 V_{DC}	9 = RSVD *
2 = 5.4 V_{DC}	6 = 9.0 V_{DC}	0 = RSVD *
3 = 6.3 V_{DC}	7 = 9.9 V_{DC}	
4 = 7.2 V_{DC}	8 = 10.8 V_{DC}	

Nominal Lamp Operating Voltage

1 = 250 V_{RMS}	5 = 450 V_{RMS}	9 = RSVD *
2 = 300 V_{RMS}	6 = 500 V_{RMS}	0 = RSVD *
3 = 350 V_{RMS}	7 = 550 V_{RMS}	
4 = 400 V_{RMS}	8 = 600 V_{RMS}	

Maximum Lamp Start Voltage

1 = 600 V_{RMS}	4 = 900 V_{RMS}	7 = 1200 V_{RMS}
2 = 700 V_{RMS}	5 = 1000 V_{RMS}	8 = 1300 V_{RMS}
3 = 800 V_{RMS}	6 = 1100 V_{RMS}	9 = 1400 V_{RMS}

Nominal Lamp Operating Current at Full Brightness

1 = 2 mA_{RMS}	5 = 6 mA_{RMS}	9 = RSVD *
2 = 3 mA_{RMS}	6 = 7 mA_{RMS}	0 = RSVD *
3 = 4 mA_{RMS}	7 = 10 mA_{RMS}	
4 = 5 mA_{RMS}	8 = 12 mA_{RMS}	

Reserved

Mechanical Configuration

See following Specific Data Sheets

RSVD = Reserved for Special Requirements
* Note: Other configurations are available. If you need a configuration not listed above please call us.

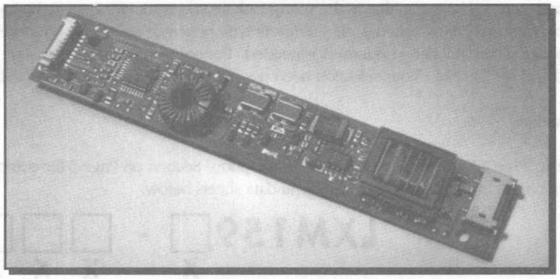
LXM1590/LXM1591

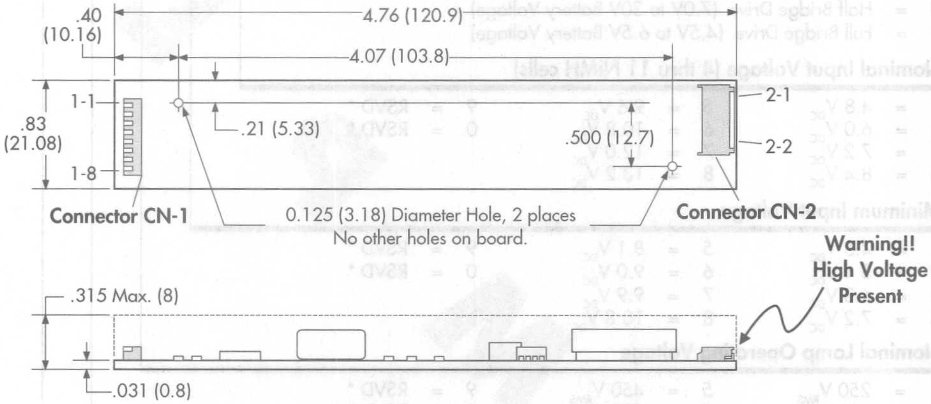
CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

PHYSICAL DIMENSIONS

LXM1590-xxxxx-01





All dimensions in inches (mm)

CN-1 = MOLEX 53261-0890

CN-2 = JST SM02(8.0) B-BHS-TB

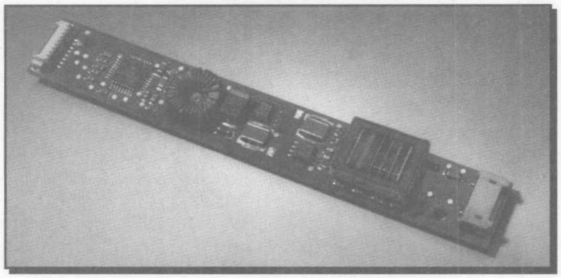
Connector Pinouts

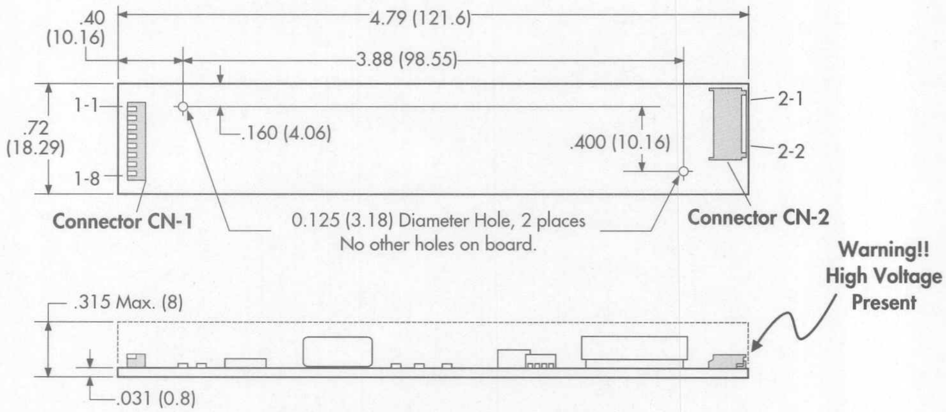
CN1-1 = V_{IN}	CN1-5 = GND	CN2-1 = LAMP HI
CN1-2 = V_{IN}	CN1-6 = $\overline{\text{SLEEP}}$	CN2-2 = LAMP LO
CN1-3 = V_{CC}	CN1-7 = BRITE	
CN1-4 = GND	CN1-8 = V_{REF}	

LINFINITY MICROELECTRONICS

PHYSICAL DIMENSIONS

LXM1591-xxxxx-01





All dimensions in inches (mm)

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Connector Pinouts

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CN1-2 = V_{IN}	CN1-6 = BRITE	CN2-2 = LAMP LO
CN1-3 = GND	CN1-7 = AGND	
CN1-4 = GND	CN1-8 = V_{REF}	

LINFINITY MICROELECTRONICS

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1592/LXM1593

FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

The LXM1592/93 series of floating output drive CCFL (Cold Cathode Fluorescent Lamp) Inverter Modules are specifically designed to drive large LCD displays (11.3" and larger), which are used in notebook computers. These new inverters were specifically designed to reduce the leakage currents from the lamp to the reflector or the metal frame of the panels. The floating output architecture of these inverters also permits a much wider dimming range when compared to non-floating designs, and an additional 10% efficiency improvement is realized.

Both the LXM1592 and LXM1593 are fully customizable (electronically and mechanically) to specific customer requirements.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from these *single* stage resonant inverters, featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp, enabling maximum light delivery, while reducing both conducted and radiated noise. This topology simultaneously performs two tasks including line voltage regulation and lamp dimming through lamp current regulation. These two functions are performed in a single power stage made up of a pair of low-loss MOSFETs. The MOSFETs drive a low current resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low-loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

Two module versions are available. The half-bridge LXM1592 provides peak efficiency when operated at input voltages above 7 volts. The LXM1593 achieves higher efficiency at input voltages above 4.5V with its full-bridge drive circuit.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut-down mode.

Each module features output open and short circuit protection.

KEY FEATURES

- FULLY FLOATING OUTPUT
- 35% MORE LIGHT OUTPUT AT 2.5 WATTS
- GREATER EFFICIENCY THAN GROUNDED OUTPUT DESIGNS
- 4.5V TO 30V INPUT VOLTAGE RANGES
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- MINIMIZE THERMOMETER EFFECTS
- MINIMIZE LAMP TO PANEL LEAKAGE CURRENT

APPLICATIONS

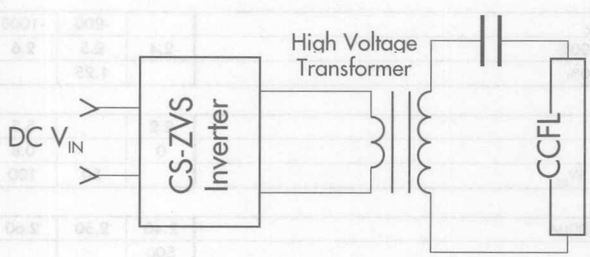
- 11.3" LCD PANELS AND LARGER
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW-PROFILE STANDARD MODULES FIT INTO MOST LCD ENCLOSURES
- SINGLE-SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

PRODUCT HIGHLIGHT

FLOATING OUTPUT ARCHITECTURE



MODULE ORDER INFORMATION

HALF-BRIDGE DRIVE	FULL-BRIDGE DRIVE
LXM1592-xxxxx-zz	LXM1593-xxxxx-zz

See instructions inside for completing module part number.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LXM1592/LXM1593

FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... LXM1592 = -0.3V to 30V / LXM1593 = -0.3 to 7.0V
Output Voltage, no load .... Internally Limited to 1700V_{RMS}
Output Current .... 7.0mA_{RMS} (Internally Limited)
Output Power 4.5W
Input Signal Voltage, (SLEEP and BRITE Inputs) .... -0.3V to 6.5V
Ambient Operating Temperature, zero airflow .... 0°C to 60°C
Storage Temperature Range .... -40°C to 85°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

*This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the '**R.C.**' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.*

Parameter		Symbol	Recommended Operating Conditions Min.	R.C.	Max.	Units
Input Supply Voltage	LXM1592	V_{IN}	7	12	30	V
	LXM1593		4.5		6.5	V
Output Power		P_O		2.5	4.2	W
Brightness Control Input Voltage Range		V_{BRITE}	0.8		2.5	V
Lamp Operating Voltage		V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness		I_{OLAMP}		5	6.5	mA_{RMS}
Operating Ambient Temperature Range		T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1592/1593.

Parameter	Symbol	Test Conditions	LXM1592/1593 Min.	Typ.	Max.	Units
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L(MAX)}$	$V_{BRITE} = 2.5\ V_{DC}$, $\overline{SLEEP}$ = Logic High	5.9	6.2	6.5	mA
Minimum Lamp Current	$I_{L(MIN)}$	$V_{BRITE} = 0.8\ V_{DC}$, $\overline{SLEEP}$ = Logic High		2.0		mA_{RMS}
Lamp Start Voltage	V_{LS}	$0°C < T_A < 60°C$	1200			V_{RMS}
Operating Frequency	f_O	$V_{BRITE} = 2.5V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 12V$		70		KHz
Brightness Control						
Input Current	I_{BRITE}	$V_{BRITE} = 0V_{DC}$		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O(LAMP)} = 100\%$	2.4	2.5	2.6	V_{DC}
Input Voltage for 50% Lamp Current	V_C	$I_{O(LAMP)} = 50\%$		1.25		V_{DC}
SLEEP Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}} = 0 - 5V_{DC}$		50	100	μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	$0 < I_{REF} < 500\mu A$	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		500			μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN(MIN)}$	$V_{IN} = 5V_{DC}$, $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	LXM1592, $V_{IN} = 12V_{DC}$, $I_{O(LAMP)} = 5mA_{RMS}$		92		%
		LXM1593, $V_{IN} = 5V_{DC}$, $I_{O(LAMP)} = 5mA_{RMS}$		90		%

LINFINITY MICROELECTRONICS

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+4.5 to +30V_{DC})
CN1-3 CN1-4	GND	Power supply return.
CN1-5	$\overline{SLEEP}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{SLEEP}$ through a 33kΩ resistor to V_{IN} or directly to any voltage between 2.5 and 5.5V.
CN1-6	BRITE	Brightness control input. Apply 0.9 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. Open circuit or 2.5V gives maximum brightness.
CN1-7	AGND	Brightness control signal return. For best results do not run V_{IN} power supply current return through this pin.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP HI	High-voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.
CN2-2	LAMP LO	High-voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.

TECHNICAL / ANALYSIS INFORMATION

INTRODUCTION

This section discusses some general topics in testing and evaluating Cold Cathode Fluorescent Lamps (CCFL) along with the inverters that drive them as they are used in active and passive matrix LCD displays. In particular, this discussion will concentrate on the testing of the Current Synchronous Zero Voltage Switching Inverter.

The past two years have seen a rapid change in the types of available LCD displays, as well as their lighting and inverter systems.

Significant strides have been made in the light transmission efficiencies of the optical systems in addition to efficiency gains in their lighting and inverter systems. At the same time, some of these improvements, especially in the reflector and lamp housing systems, now pose difficulties when driving these lamps.

The discussion which follows will examine lighting characteristics of the CCFL's and experimental data which can be used to determine the duration of time that it takes for the light output from the CCFL to stabilize. In addition, light output efficiency calculation methods will be presented that can help sort out various efficiency claims from different inverter manufacturers.

As part of the following discussion, the parasitics of the CCFL/Panel system will be modeled and SPICE simulations will reveal the current profile in the lamp. Finally, actual performance data will be presented comparing non-floating versus floating secondaries, with an analysis of this data.

LIGHTING CHARACTERISTICS OF CCFLs

The duration of time that it takes for the light output to stabilize must first be determined before any meaningful measurements can be made. This is important when trying to maintain consistency between measurements, and is also important in minimizing the required testing time.

Several factors affect the light output of the CCFL's, such as operating current waveshape and frequency, proximity of the lamp to conducting surfaces, inverter output configuration, and ambient temperature, among other things. In addition, the newer lamps have very small diameters and operate at higher gas pressures. It appears that this makes these lamps electrically more unstable.

In order to determine the time required to reach steady state for a particular lighting system in this test, a completely automated data acquisition system has been set up that is capable of taking light output data at uniform time intervals. The power supply, the ammeter and voltmeter are all controlled by the computer. The photometer's RS-232 port is connected to the RS-232 port of the computer. Figure 1 shows a block diagram of this setup.

With this setup, the calculation of the power input and efficiencies is greatly simplified, because automation and data gathering consistency are assured.

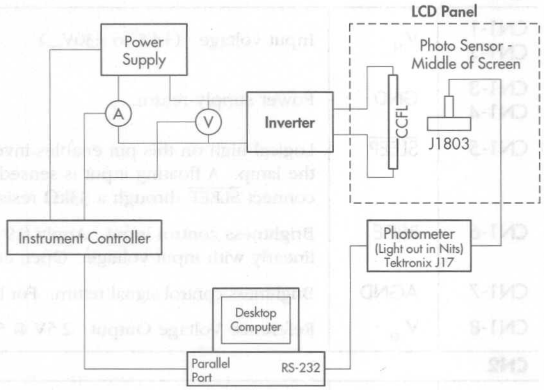


FIGURE 1 — MEASUREMENT SETUP

100 samples are taken from a system at 3 second intervals consisting of the following:

1. Lamp type: 560Vrms Operating at 5-6mA.
2. Inverter type: Half-bridge floating output CS-ZVS inverter at 10V input.
3. Lamp is housed in a 11.3" active matrix LCD panel.
4. The panel is laid flat on a desk with the photometer placed at the center of the panel.

The result of these measurements is shown in Figure 2. This figure shows the initial turn-on profile of the lamp under specific environmental conditions.

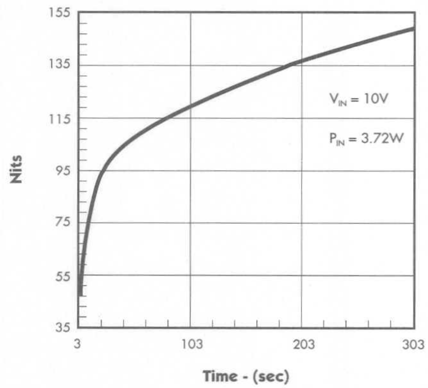


FIGURE 2 — INITIAL TURN-ON CHARACTERISTICS OF THE CCFL IN A HIGH-EFFICIENCY 11.3" LCD PANEL

TECHNICAL / ANALYSIS INFORMATION (continued)

LIGHTING CHARACTERISTICS OF CCFLs (continued)

The rapid increase of light output during the first few seconds of this test is due to the fact that mercury vapor inside the CCFL reaching steady state concentration. The continual increase of light output from the lamp at a slower rate is a result of the thermal time constants of the system. Essentially, as the lamp gets warmer, it tends to become more efficient.

Figure 3 shows the light output efficiency of the system as calculated by using the following formula.

$$Eff = \frac{\text{Light Out (Nits)}}{\text{Power In (Watts)}}$$

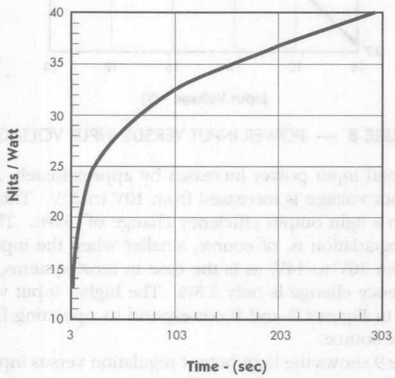


FIGURE 3 — LIGHT OUTPUT EFFICIENCY PROFILE DURING INITIAL TURN ON

Figure 3 clearly shows the increase in efficiency as the lamp in the panel is self heating. This graph also shows that 303 seconds is not a sufficient amount of time for this system to reach a steady state. Figure 5 shows what the required amount of time is for this system to reach a steady state.

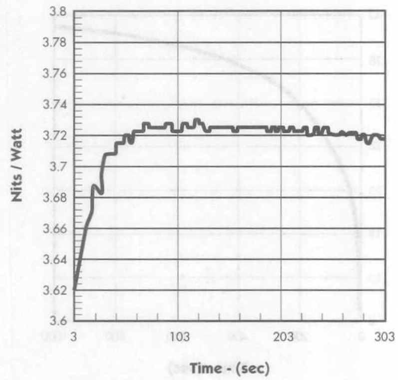


FIGURE 4 — INVERTER POWER INPUT PROFILE DURING INITIAL TURN ON

Figure 4 shows the inverter power input profile during initial turn on. It is interesting to note that, when the inverter is first turned on, the input power is lower. This is a result of the higher impedance of the lamp. It takes a finite amount of time for the mercury to fully vaporize, thereby reducing the impedance of the lamp and permitting it to reach a steady state in terms of power.

Figures 5 and 6 show the above-mentioned system at a slightly different input power taken at a different time than the previous graphs. The light output and efficiency data is probably different because of a different ambient temperature. The sampling interval for these graphs was set at 10 seconds.

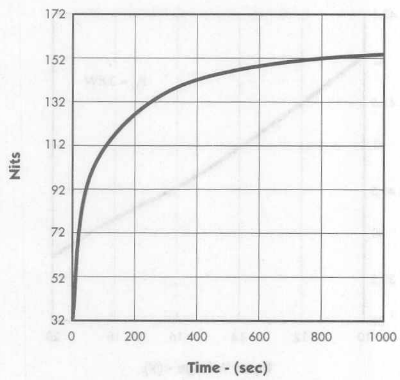


FIGURE 5 — LIGHT OUTPUT VERSUS TIME AT INITIAL TURN ON, 10sec SAMPLING PERIOD

TECHNICAL / ANALYSIS INFORMATION (continued)

LIGHTING CHARACTERISTICS OF CCFLs (continued)

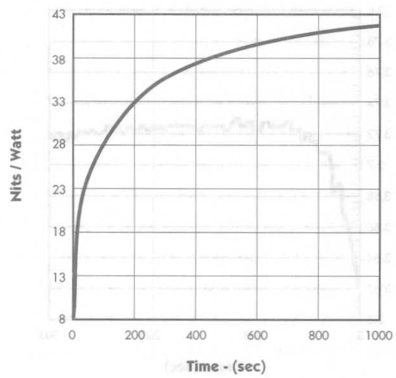


FIGURE 6 — LIGHT OUTPUT EFFICIENCY VERSUS TIME AT INITIAL TURN ON, 10sec SAMPLING PERIOD

Based on the graphs of Figures 5 and 6, it can be determined that this system reaches steady state in approximately 17 minutes.

INVERTER INPUT VOLTAGE CONSIDERATIONS

Almost all power conversion devices lose some efficiency when operated at voltages beyond their nominal values. In order to investigate the effect of input voltage variation on the light output efficiency, the input voltage to the inverter has been varied from its minimum to its maximum operating condition. The results of this effort are shown in Figures 7 and 8.

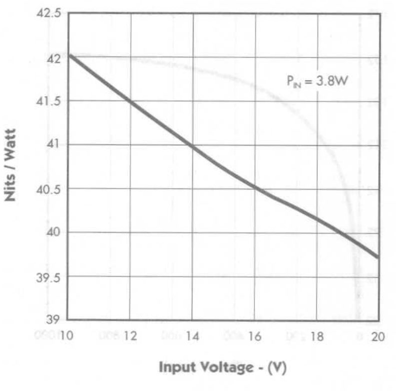


FIGURE 7 — LIGHT OUTPUT EFFICIENCY VERSUS INPUT VOLTAGE

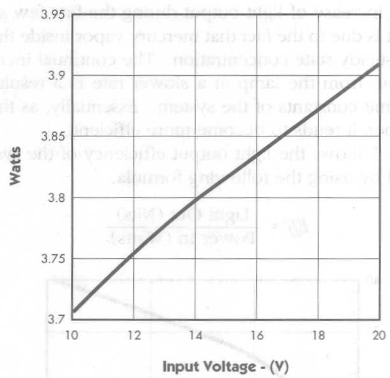


FIGURE 8 — POWER INPUT VERSUS INPUT VOLTAGE

The total input power increases by approximately 200mW when input voltage is increased from 10V to 20V. This corresponds to a light output efficiency change of 5.8%. This efficiency degradation is, of course, smaller when the input voltage is from 10V to 14V, as is the case in most systems, where the efficiency change is only 2.8%. The higher input voltages depicted in Figures 7 and 8 correspond to operating from an AC power source.

Figure 9 shows the light output regulation versus input voltage. This graph shows the excellent light output (line) regulation characteristic of a CS-ZVS inverter with the floating output. The total line regulation is only ±0.23% because of this the purity of the lamp drive current as well as the true load current sensing capability of this circuit.

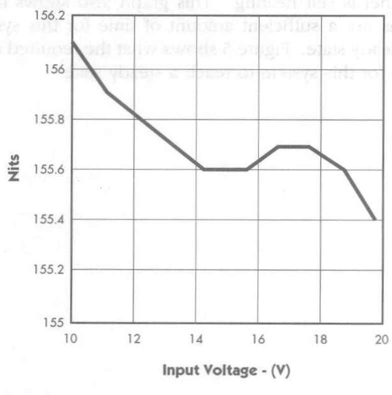


FIGURE 9 — LIGHT OUTPUT VERSUS INPUT VOLTAGE LIGHT OUTPUT REGULATION

LINFINITY MICROELECTRONICS

TECHNICAL / ANALYSIS INFORMATION (continued)

INVERTER INPUT VOLTAGE CONSIDERATIONS (continued)

All the information discussed thus far can be very useful when trying to design the power subsystem. The minimal decrease in efficiency of the CS-ZVS inverter enables the system designer to have a relatively wide operating input voltage range without a significant efficiency penalty.

The inverter is normally designed for the minimum battery voltage. Efficiency is optimized when the minimum operating voltage is as close as possible to the nominal operating voltage.

A FEW WORDS ON NEW LCD PANEL DISPLAYS

Significant efficiency improvements have been made to the optical systems of newer, larger LCD panels, panels that are typically 11.3" inches and larger. However, these improvements, including improvements in the lightpipe, the reflector and the CCFL itself, have caused increased leakage currents from the lamp to the reflector and/or panel's metal frame. This condition results in degraded light output and reduced dimming ranges, when used with backlight inverters equipped with non-floating (or grounded) high voltage sides. Further compounding the leakage current problem is an increase of the operating voltages of CCFL's, with some lamps requiring as high as $650V_{RMS}$ to operate.

In a non-floating or grounded inverter, the output of the high-voltage transformer is referenced to ground, permitting leakage currents to circulate between the panel, the system ground and the inverter ground. In order to address these leakage currents, a new inverter configuration has been designed by Linfinity, which uses a floating output drive, coupled with Linfinity's patent pending CS-ZVS technology.

Generally speaking, in a floating output drive, the high-voltage side of the inverter transformer is not referenced to ground and, therefore, interrupts the path of the leakage currents, preventing them from flowing into the system ground. Because the Linfinity LXM1592 and LXM1593 are configured with a unique combination of Linfinity's floating output architecture and CS-ZVS technique, they significantly reduce the leakage currents from the lamp to the reflector of the metal frame of the panel, further improving the efficiency of these newer inverters over non-floating, or grounded designs. The LXM1592 and LXM1593, equipped with the Linfinity floating output drive architecture, yield an additional 10% improvement in light output and also permit a wider dimming range, resulting in a more uniformly-lighted, as well as more efficient and brighter panel. Linfinity's floating output drive scheme, which currently is the only design which senses the secondary side lamp current, achieves very accurate lamp current regulation and, as such, is unique and superior even to other floating output implementations.

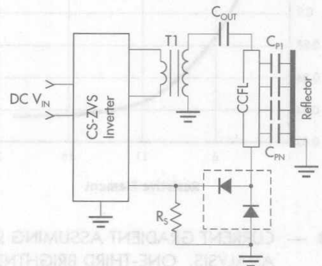


FIGURE 10 — NON-FLOATING OUTPUT CONFIGURATION. C_{P1} THROUGH C_{PN} REPRESENT DISCRETIZED DISTRIBUTED PARASITIC CAPACITANCE

SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM

Non-Floating Configuration

Figure 10 shows the electrical configuration of a non-floating drive. In this system, the CCFL current is being sensed with a resistor referenced to the inverter ground. The panel, along with the reflector, is also electrically "tied" to the inverter ground.

A "thermometer effect" (or brightness gradient) is created when the parasitic capacitance and the reflector are diverting useful current from the lamp to ground. This effect is very intense in some of the newer panels because the reflector is metal or metal-coated plastic or is situated very close to the panel itself. An additional side effect of this leakage is a marked reduction of efficiency.

The following experiment was performed in order to quantify this capacitance. A lamp was broken at both cathode ends and an AWG#18 bus wire was inserted through the tube. This assembly was then placed in the cavity of a metal reflector and the capacitance was measured using a standard RLC bridge. The measured parasitic capacitance was approximately 15pF. Normally this capacitance is distributed along the length of the tube. Also, the lamp wiring formed a parasitic capacitance with the metal frame, which in this case was about 14pF.

With the above information, a simple discrete distributed electrical model was constructed to help analyze the system. This electrical model of the non-floating configuration is shown in Figure 11.

The parasitic shunt capacitors shown as C_{P1}-C_{PN} produce a current gradient across the length of the lamp that results in the "thermometer effect" that exhibits itself as a brightness gradient. In extreme cases, this exhibits itself as partial lighting of the lamp with the "hot" side of the lamp being the brightest.

TECHNICAL / ANALYSIS INFORMATION (continued)

SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM (con't.)

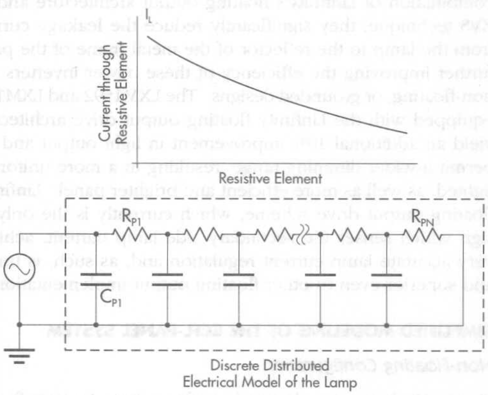


FIGURE 11 — NON-FLOATING OUTPUT CONFIGURATION. ELECTRICAL MODEL OF LAMP THAT SHOWS THE CURRENT PROFILE AS A RESULT OF THE PARASITIC SHUNT CAPACITANCE

In order to study the effects of the parasitic capacitance, the lamp was divided into 20 identical segments, consisting of both resistive and capacitive elements. Assuming a full brightness operating impedance of 100KΩ, each individual resistive element would be 5KΩ and each capacitance would be 0.75pF. The circuit then was solved by using a circuit simulator, such as SPICE. The capacitance of the wiring in the non-floating drive was inconsequential and was ignored. The accuracy of the above model is thought to be limited because of the nonlinear nature of the lamp impedance along the lamp length as a result of the thermometer effect (resulting in impedance modulation).

Figure 12 shows the result of SPICE simulation on the 20 element model. Impedance was adjusted for 600V and 6mA operation. This graph shows the variation of the current flow in the resistive elements of the lamp that produces light output. Furthermore, it shows that the current is higher at the "hot" end of the lamp by 2.4%. The effect of this is minimal light non-uniformity from one end of the lamp to the other. This is also apparent in the real circuit.

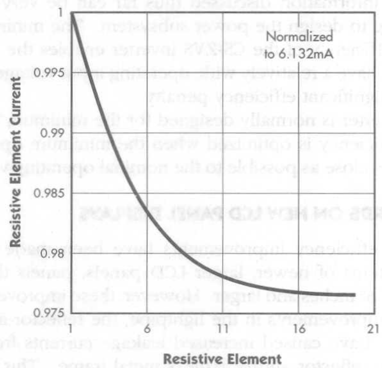


FIGURE 12 CURRENT GRADIENT ASSUMING 20 ELEMENT ANALYSIS. FULL BRIGHTNESS

Figure 13 shows the result of SPICE simulation on the above 20 element model when the lamp is dimmed to 1/3 brightness. Impedance was adjusted in this case for 600V and 2mA operation. The current differential in this case was 20%. The consequence of this is that the brightness change from one end of the lamp to the other will likely be more than 25%, a variance which is clearly visible to the human eye.

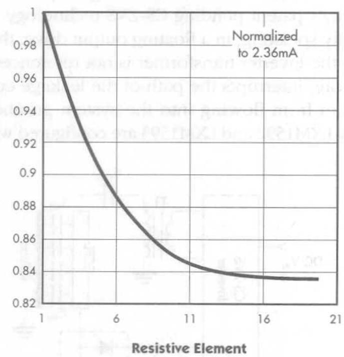


FIGURE 13 — CURRENT GRADIENT ASSUMING 20 ELEMENT ANALYSIS. ONE-THIRD BRIGHTNESS LEVEL

TECHNICAL / ANALYSIS INFORMATION (continued)

SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM (con't.)

Figure 14 shows the electrical configuration of a floating drive. In this system, the CCFL current is being sensed either in the primary side of the high-voltage transformer or at the secondary side. The panel and the reflector are electrically connected to the primary side (of T1) inverter ground.

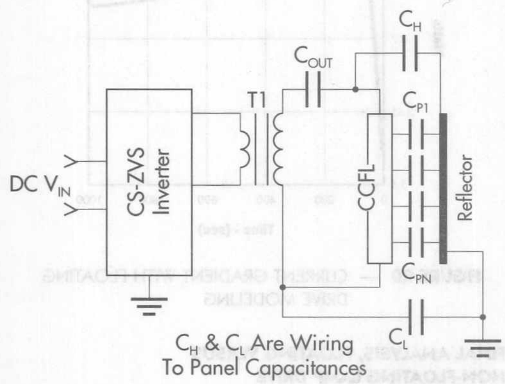


FIGURE 14 — FLOATING OUTPUT CONFIGURATION

Figure 16 shows the result of SPICE simulation on the circuit of Figure 15, again with a 20-element model.

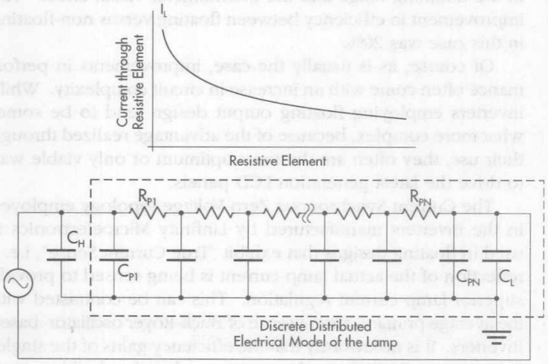


FIGURE 15 — FLOATING OUTPUT CONFIGURATION ELECTRICAL MODEL OF LAMP

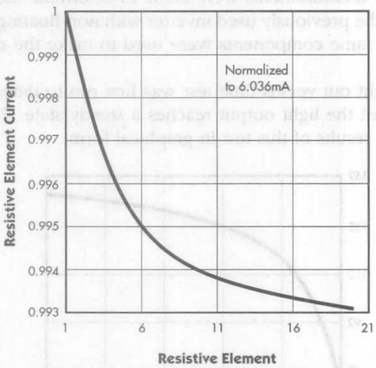


FIGURE 16 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

The total current deviation in this case is 0.7%. Although this a small deviation, it is expected that in a real physical circuit, the difference would be higher as a result of other unmodelled parasitics and lamp non-linearities.

Figure 17 shows the simulation results for the dimmed case of the floating drive. The total current deviation in this case is 6.1%. Thus, the floating drive introduces a smaller brightness gradient than the non-floating drive, resulting in a more uniformly lighted panel.

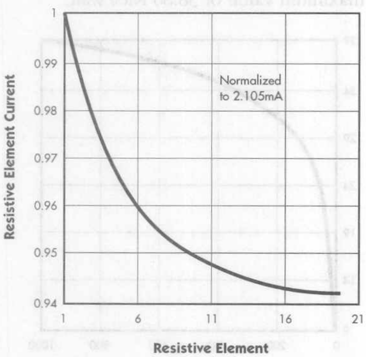


FIGURE 17 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

TECHNICAL / ANALYSIS INFORMATION (continued)

NON-FLOATING INVERTER MEASUREMENTS

A series of measurements were made to determine the performance of the previously used inverter with non-floating output. The exact same components were used to make the comparison.

The light out versus time test was first run to determine at which point the light output reaches a steady state. Figure 18 shows the results of this test in graphical form.

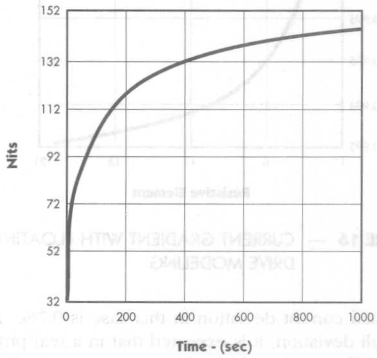


FIGURE 18 — LIGHT OUT VERSUS TIME AT INITIAL TURN ON FOR NON-FLOATING INVERTER

The light out efficiency versus time curve then has been calculated by using the light out and the power input data (Figure 20). The results of this effort are shown in Figure 19. As expected, light out efficiency improves as the lamp warms up reaching a maximum value of 38.86 Nits/Watt.

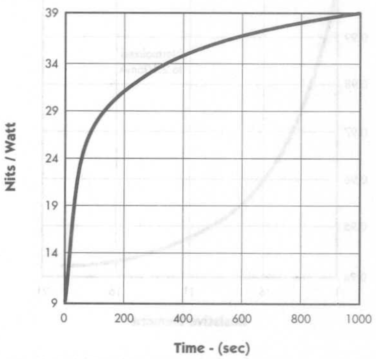


FIGURE 19 — LIGHT OUT EFFICIENCY VERSUS TIME AT INITIAL TURN ON FOR NON-FLOATING INVERTER

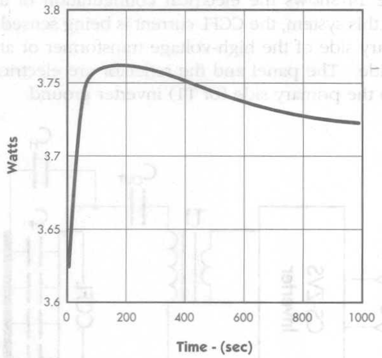


FIGURE 20 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

FINAL ANALYSIS, FLOATING VERSUS NON-FLOATING LAMP DRIVE

Table 1 summarizes the performance differences between the floating and non-floating drive configurations evaluated in the testing discussed above. As has been seen, the performance gains strongly depend on the physical configuration of the lamp and the reflector assembly. One of the panels that was tested exhibited higher leakage, along with a significant improvement in the dimming range and the thermometer visual effect. The improvement in efficiency between floating versus non-floating in this case was 20%.

Of course, as is usually the case, improvements in performance often come with an increase in circuit complexity. While inverters employing floating output design tend to be somewhat more complex, because of the advantage realized through their use, they often are the most optimum or only viable way to drive the latest generation LCD panels.

The Current Synchronous Zero Voltage topology employed in the inverters manufactured by Linfinity Microelectronics is used in floating designs that exhibit "True Current Sense", i.e. a reflection of the actual lamp current is being sensed to provide superior lamp current regulation. This can be contrasted with the average primary current sense of Buck-Royer oscillator- based inverters. It is noteworthy that the efficiency gains of the single-power stage CS-ZVS topology compared to the double power stage Buck-ROYER combinations is more that 20%.

TECHNICAL / ANALYSIS INFORMATION (continued)

TABLE 1

Parameter	Floating		Non-Floating		Improvement over Non-Floating	
Input Power	3.175 Watts		3.726 Watts		-0.3%	
Light Output	154.3 Nits		144.8 Nits		6.56%	
Light Out Efficiency	41.5 Nits/Watt		38.86 Nits/Watt		6.8%	
Percent Max-Min Current Difference Because of Parasitics (note 1)	0.7% at Full Bright	6.1% at 1/3 Dimmed	2.4% at Full Bright	20% at 1/3 Dimmed	242% at Full Bright	227% at 1/3 Dimmed
Dimming Range (note 2)	To 50% of full Brightness Current		To 65% of full Brightness Current			

Note 1. This refers to the max and min currents in resistive elements of the 20 element analysis. The parasitics used did not pertain exactly to the 11.3" LCD panel used to make the measurements. The results are provided for comparison purposes. It is expected that the parasitics of the panel used to make the light measurements are lower than those depicted.

Note 2. Dimming range here is defined as the point where a visible "thermometer" effect just takes place.

SUMMARY

Several new ways for testing CCFL's and inverters have been presented. The emphasis throughout these tests has been on how to make fair comparisons. To that end, a method has been presented that makes certain that the light output has reached steady state with all inverters tested, thus guaranteeing fair comparisons.

The lamp/reflector parasitics were modeled and the lamp current profile was calculated based on these models. This gave insights on the effect of the parasitics either when the lamp is at full brightness or dimmed. Both the non-floating and floating inverter designs were considered and analyzed.

The use of a floating lamp architecture resulted in approximately a 6.8% improvement in light output efficiency when it was compared to a non-floating design. The dimming range with the floating drive was also better by more than 15%.

The comparison between the floating versus the non-floating drive designs were presented in tabular form for easy evaluation.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS

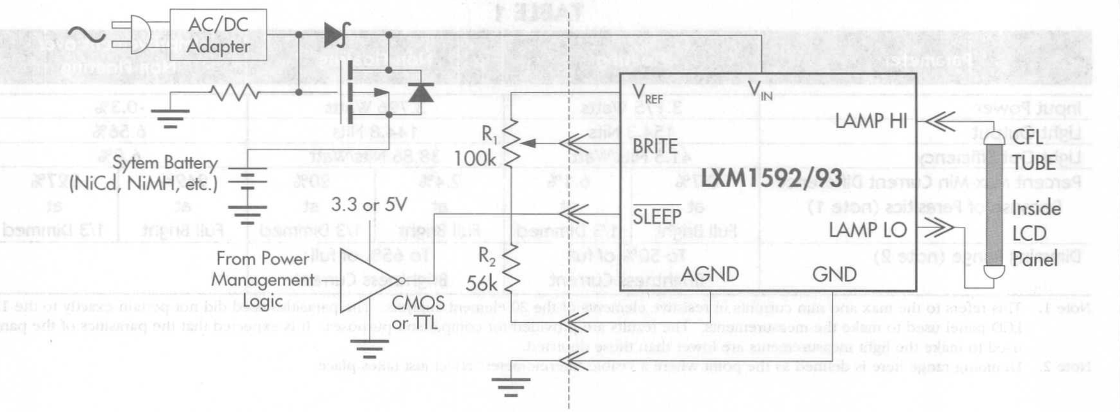
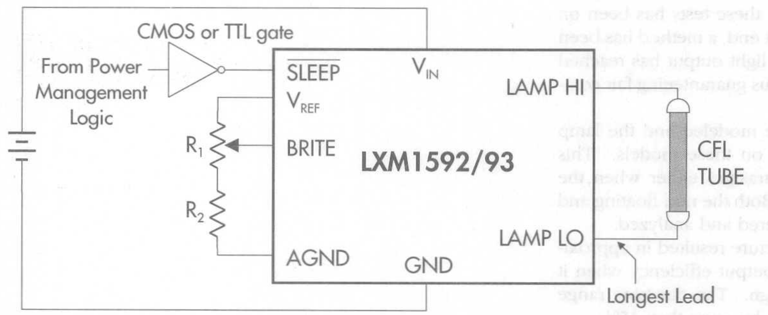


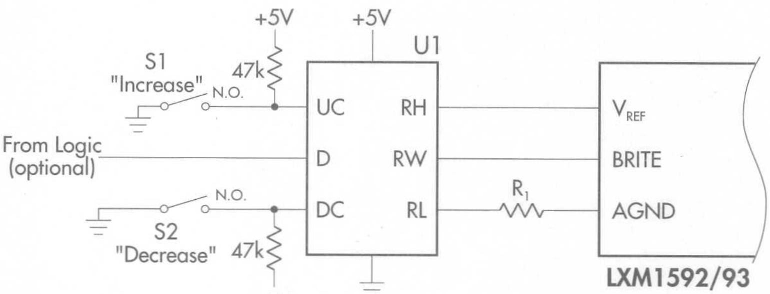
FIGURE 21 — NOTEBOOK SYSTEM APPLICATION



$$\text{Lamp Current (\%)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

R_1 = 100k typical, 5k minimum
R_2 = Value optional to determine lowest brightness setting
R_2 = 0.5 R_1 minimum

FIGURE 22 — POTENTIOMETER BRIGHTNESS CONTROL & SLEEP MODE

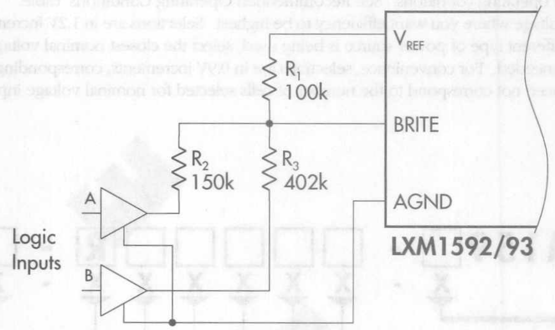


- S1 & S2 are momentary push buttons, normally open contacts.
- U1 = 100k digital pot.
- R_1 value optional for choosing dimming range:
  for R_1 = 100k, Range = 100% to 50%
  for R_1 = 50k, Range = 100% to 33%
- R_1 minimum value is 0.5 R_{POT}.

FIGURE 23 — NONVOLATILE DIGITAL BRIGHTNESS CONTROL

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS (continued)

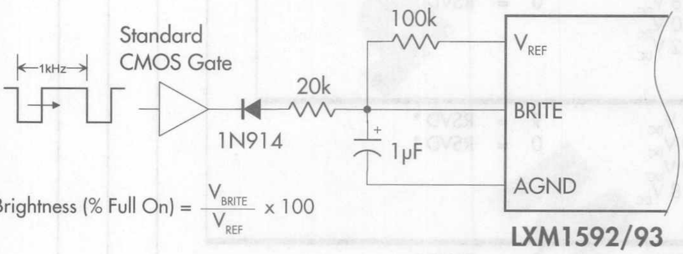


- Drivers are open collector.
- Run separate ground from driver chip to LXM1592/93 AGND to prevent noise pickup.
- This scheme may be expanded to 3 or 4 bits for more resolution.

$$\text{Lamp Current (\% Full On)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

A	B	Lamp Current
0	0	52%
0	1	60%
1	0	80%
1	1	100%

FIGURE 24 — LOW COST DIGITAL BRIGHTNESS CONTROL



$$\text{Brightness (\% Full On)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

Input Duty Cycle	Lamp Current
* 100%	100%
50%	70%
0%	33%

* 100% DC is a logic HI at CMOS gate input.

FIGURE 25 — PWM BRIGHTNESS CONTROL

COMPLETING THE MODULE PART NUMBER

1. Choose either the half or full-bridge version by determining your operating conditions. See Recommended Operating Conditions Table.
2. Choose the nominal input voltage you will be using, that is, the voltage where you want efficiency to be highest. Selections are in 1.2V increments to match the 1.2V/cell potential of NiCd and NiMH batteries. If a different type of power source is being used, select the closest nominal voltage.
3. Choose the minimum input voltage where full lamp brightness is needed. For convenience, selections are in 0.9V increments, corresponding to end of discharge potential for NiCd and NiMH cells. Your selection need not correspond to the number of cells selected for nominal voltage input.
4. Specify lamp running voltage.
5. Specify maximum lamp start voltage.
6. Specify lamp running current.

LXM159□ - □□□□□R - □□

X - X X X X X X - Z Z

Module Type

2	=	Half-Bridge Drive (7.0V to 30V Battery Voltage)			
3	=	Full-Bridge Drive (4.5V to 6.5V Battery Voltage)			

Nominal Input Voltage (4 thru 11 NiMH cells)

1	=	4.8 V_{DC}	5	=	9.6 V_{DC}	9	=	RSVD *
2	=	6.0 V_{DC}	6	=	10.8 V_{DC}	0	=	RSVD *
3	=	7.2 V_{DC}	7	=	12.0 V_{DC}			
4	=	8.4 V_{DC}	8	=	13.2 V_{DC}			

Minimum Input Voltage

1	=	4.5 V_{DC}	5	=	8.1 V_{DC}	9	=	RSVD *
2	=	5.4 V_{DC}	6	=	9.0 V_{DC}	0	=	RSVD *
3	=	6.3 V_{DC}	7	=	9.9 V_{DC}			
4	=	7.2 V_{DC}	8	=	10.8 V_{DC}			

Nominal Lamp Operating Voltage

1	=	250 V_{RMS}	5	=	450 V_{RMS}	9	=	RSVD *
2	=	300 V_{RMS}	6	=	500 V_{RMS}	0	=	RSVD *
3	=	350 V_{RMS}	7	=	550 V_{RMS}			
4	=	400 V_{RMS}	8	=	600 V_{RMS}			

Maximum Lamp Start Voltage

1	=	600 V_{RMS}	4	=	900 V_{RMS}	7	=	1200 V_{RMS}
2	=	700 V_{RMS}	5	=	1000 V_{RMS}	8	=	1300 V_{RMS}
3	=	800 V_{RMS}	6	=	1100 V_{RMS}	9	=	1400 V_{RMS}

Nominal Lamp Operating Current at Full Brightness

1	=	2 mA_{RMS}	5	=	6 mA_{RMS}	9	=	RSVD *
2	=	3 mA_{RMS}	6	=	7 mA_{RMS}	0	=	RSVD *
3	=	4 mA_{RMS}	7	=	10 mA_{RMS}			
4	=	5 mA_{RMS}	8	=	12 mA_{RMS}			

Reserved

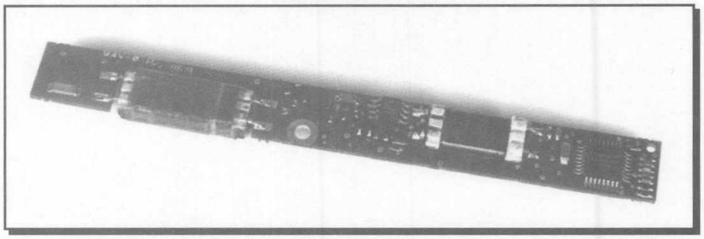
Mechanical Configuration

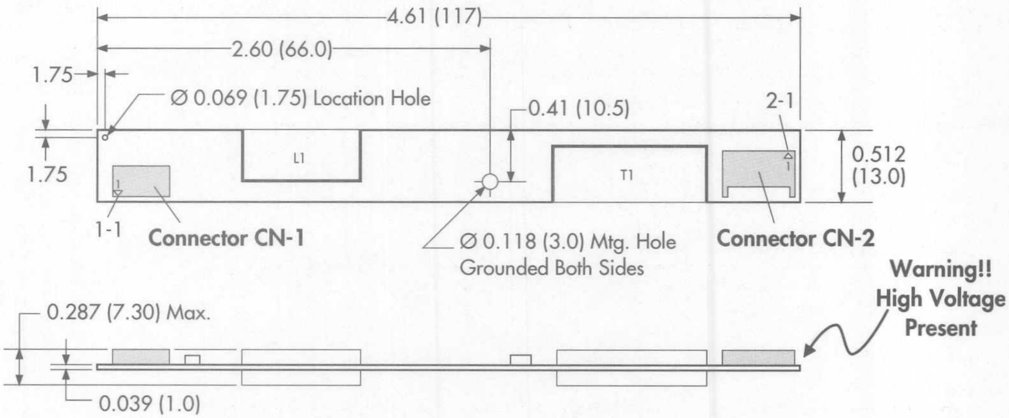
Factory Assigned

RSVD = Reserved for Special Requirements

PHYSICAL DIMENSIONS

LXM1592





All dimensions in inches (mm)

CN-1 = JST P/N: 05FMS-1.0SP

CN-2 = JST P/N: SM02-(8.0)B-BHS-1-TB

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1596-01

WIDE INPUT CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

LXM1596-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultrahigh efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its *single* stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one pair of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The half bridge LXM1596-01 is optimized to efficiently operate with up to 4 watt lamps over the full 7V to 30V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

KEY FEATURES

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 7V TO 30V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

APPLICATIONS

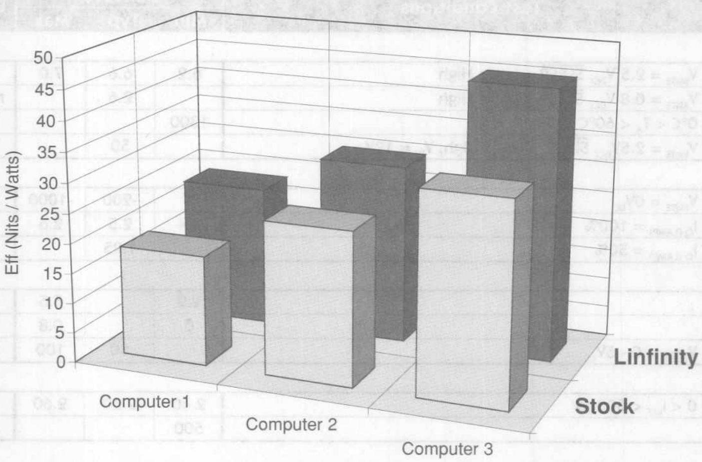
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD ENCLOSURES
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

PRODUCT HIGHLIGHT

BACKLIGHT INVERTER LIGHT OUTPUT EFFICIENCY COMPARISON



MODULE ORDER INFORMATION

7V - 30V INPUT
LXM1596-01

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LXM1596-01

WIDE INPUT CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... -0.3V to 30V
Output Voltage, no load .... Internally Limited to 1900V_{RMS}
Output Current .... 8.0mA_{RMS} (Internally Limited)
Output Power 4.2W
Input Signal Voltage, (SLEEP and BRITE Inputs) .... -0.3V to 6.5V
Ambient Operating Temperature, zero airflow .... 0°C to 60°C
Storage Temperature Range .... -40°C to 85°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

*This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the '**R.C.**' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.*

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	R.C.	Max.	
Input Supply Voltage	V_{IN}	7	12	30	V
Output Power	P_O		2.5	4.0	W
Brightness Control Input Voltage Range	V_{BRITE}	0.8		2.5	V
Lamp Operating Voltage	V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness	I_{OLAMP}		5	7	mA_{RMS}
Operating Ambient Temperature Range	T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1596.

Parameter	Symbol	Test Conditions	LXM1596			Units
			Min.	Typ.	Max.	
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L(MAX)}$	V_{BRITE} = 2.5 V_{DC}, $\overline{SLEEP}$ = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	$I_{L(MIN)}$	V_{BRITE} = 0.8 V_{DC}, $\overline{SLEEP}$ = Logic High		2.6		mA_{RMS}
Lamp Start Voltage	V_{LS}	0°C < T_A < 60°C	1300			V_{RMS}
Operating Frequency	f_O	V_{BRITE} = 2.5V_{DC}, $\overline{SLEEP}$ = Logic High, V_{IN} = 12V		50		KHz
Brightness Control						
Input Current	I_{BRITE}	V_{BRITE} = 0V_{DC}		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O(LAMP)}$ = 100%	2.4	2.5	2.6	V_{DC}
Input Voltage for 50% Lamp Current	V_C	$I_{O(LAMP)}$ = 50%		1.25		V_{DC}
SLEEP Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}}$ = 0 - 5V_{DC}		50	100	μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	0 < I_{REF} < 500µA	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		500			μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN(MIN)}$	V_{IN} = 5V_{DC}, $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	LXM1596, V_{IN} = 12V_{DC}, $I_{O(LAMP)}$ = 5mA_{RMS}		90		%

LINFINITY MICROELECTRONICS

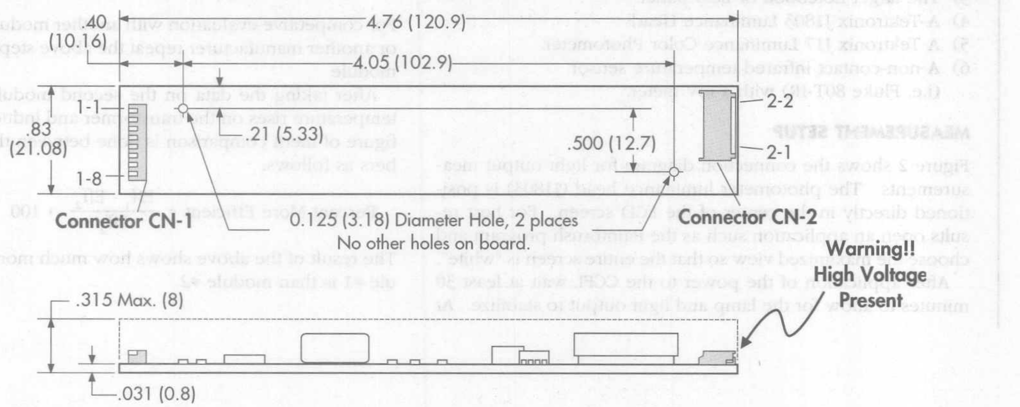
WIDE INPUT CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+7 to +30V_{DC})
CN1-3	N.C.	No Connect.
CN1-4 CN1-5	GND	Power supply return.
CN1-6	$\overline{SLEEP}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{SLEEP}$ through a 33kΩ resistor to V_{IN} or directly to any voltage between 2.5 and 5.5V. May be used to modulate lamp intensity by varying duty cycle.
CN1-7	BRITE	Brightness control input. Apply 0.8 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. 2.5V gives maximum brightness.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.
CN2-2	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.

MECHANICAL OUTLINE



All dimensions in inches (mm)

Connectors:

CN-1 = MOLEX 53261-0890

CN-2 = JST SM02(8.0) B-BHS-TB

Recommended Mate:

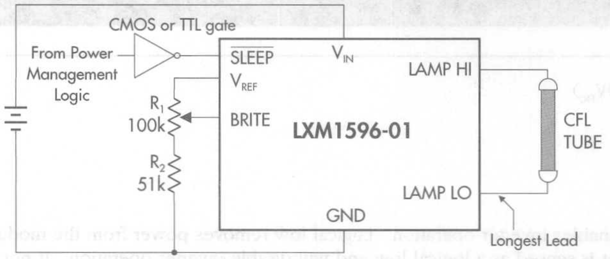
Pins: 50079-8100*, Housing: 51021-0800
* Loose (-8000, Chain) Recommended #26 AWG wiring

Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

Note: All samples are equipped with connector mates and cable.

LINFINITY MICROELECTRONICS

CONNECTION DIAGRAM



$$\text{Lamp Current (\%)} = \frac{V_{BRITE}}{V_{REF}} \times 100$$

R_1 = 100k typical, 5k minimum
R_2 = Value optional to determine lowest brightness setting
R_2 = 0.5 R_1 minimum

FIGURE 1 — RECOMMENDED CONNECTION DIAGRAM

EFFICIENCY MEASUREMENT SETUP

INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

EQUIPMENT REQUIRED

1) Two DVM's with 0.1% or better accuracy.
2) A lab power supply. (0 - 20V, 0 - 2A)
3) The target notebook or LCD panel.
4) A Tektronix J1803 Luminance Head.
5) A Tektronix J17 Luminance Color Photometer.
6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At the end of the 30 minute period read the light output in cd/m² (1 cd/m² = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$\text{Eff} = \frac{\text{Light Output (in Nits)}}{V_{IN\,(DC)} \bullet I_{IN\,(DC)}} = \frac{\text{Nits}}{\text{Watt}}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

$$\text{Percent More Efficient} = \frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} \bullet 100$$

The result of the above shows how much more efficient module #1 is than module #2.

EFFICIENCY MEASUREMENT SETUP (continued)

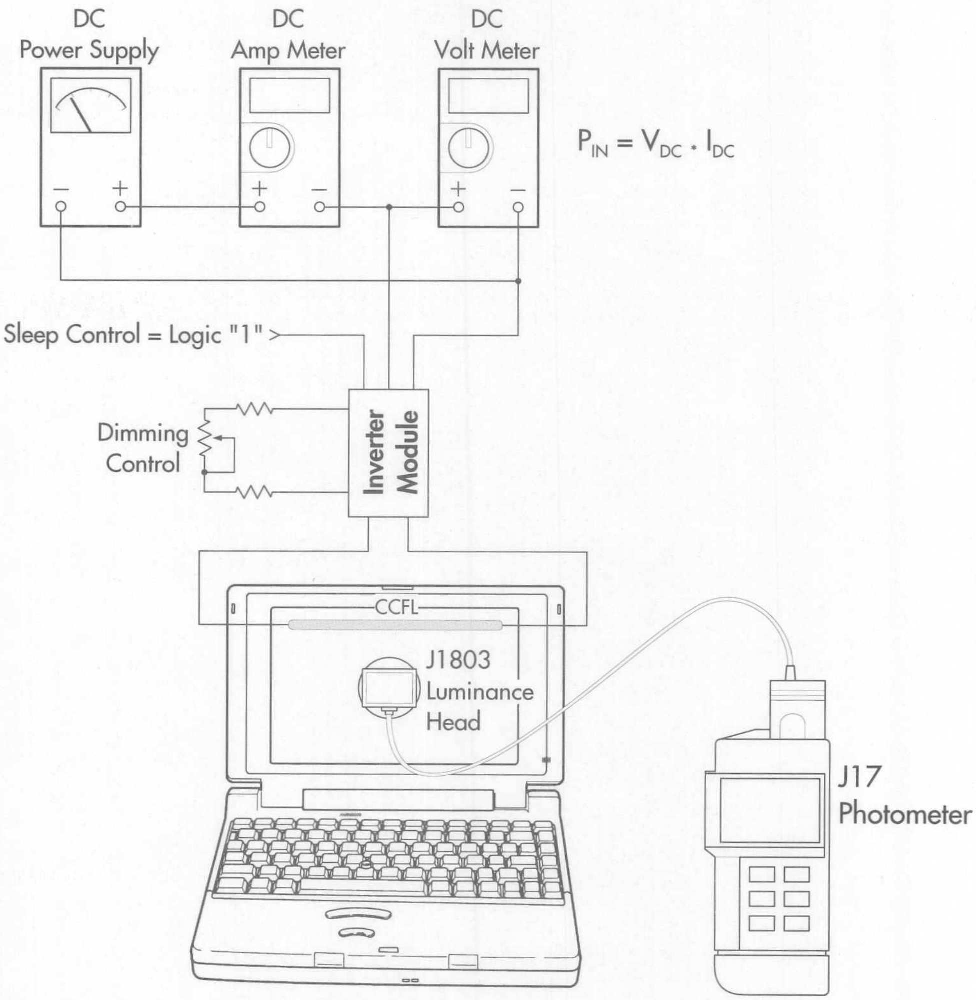


FIGURE 2 — LIGHT OUTPUT MEASUREMENT SETUP

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1597-01

5V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

LXM1597-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultra-high efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its *single* stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of two pairs of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The full bridge LXM1597-01 is optimized to efficiently operate with up to 4 watt lamps at input voltages of 5 volts. This module will operate over the full 4.5V to 7V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

KEY FEATURES

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 4.5V TO 7V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

APPLICATIONS

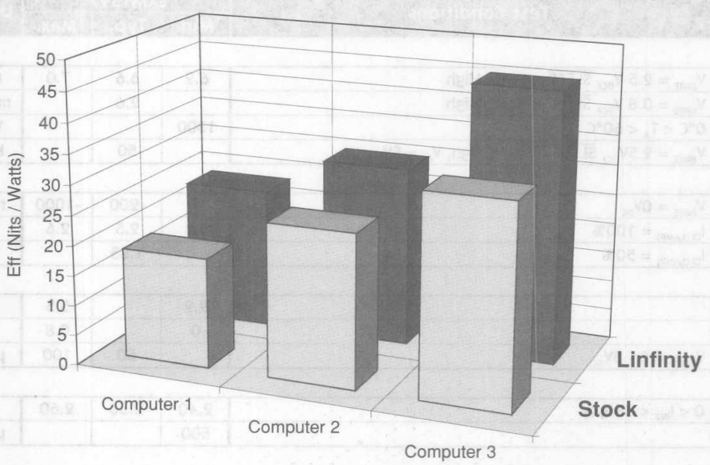
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD ENCLOSURES
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

PRODUCT HIGHLIGHT

BACKLIGHT INVERTER LIGHT OUTPUT EFFICIENCY COMPARISON



MODULE ORDER INFORMATION

5V INPUT
LXM1597-01

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LXM1597-01

5V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... -0.3V to 7.0V
Output Voltage, no load .... Internally Limited to 1900V_{RMS}
Output Current .... 8.0mA_{RMS} (Internally Limited)
Output Power 4.2W
Input Signal Voltage, (SLEEP and BRITE Inputs) .... -0.3V to 6.5V
Ambient Operating Temperature, zero airflow .... 0°C to 60°C
Storage Temperature Range .... -40°C to 85°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

*This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the '**R.C.**' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.*

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	R.C.	Max.	
Input Supply Voltage	V_{IN}	4.5	5	7	V
Output Power	P_O		2.5	4.0	W
Brightness Control Input Voltage Range	V_{BRITE}	0.8		2.5	V
Lamp Operating Voltage	V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness	I_{OLAMP}		5	7	mA_{RMS}
Operating Ambient Temperature Range	T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1597.

Parameter	Symbol	Test Conditions	LXM1597			Units
			Min.	Typ.	Max.	
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L(MAX)}$	$V_{BRITE} = 2.5\ V_{DC}$, $\overline{SLEEP}$ = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	$I_{L(MIN)}$	$V_{BRITE} = 0.8\ V_{DC}$, $\overline{SLEEP}$ = Logic High		2.6		mA_{RMS}
Lamp Start Voltage	V_{LS}	$0°C < T_A < 60°C$	1300			V_{RMS}
Operating Frequency	f_O	$V_{BRITE} = 2.5V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 5V$		50		KHz
Brightness Control						
Input Current	I_{BRITE}	$V_{BRITE} = 0V_{DC}$		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O(LAMP)} = 100\%$	2.4	2.5	2.6	V_{DC}
Input Voltage for 50% Lamp Current	V_C	$I_{O(LAMP)} = 50\%$		1.25		V_{DC}
$\overline{SLEEP}$ Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}} = 0 - 5V_{DC}$		50	100	μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	$0 < I_{REF} < 500\mu A$	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		500			μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN(MIN)}$	$V_{IN} = 5V_{DC}$, $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	LXM1597, $V_{IN} = 5V_{DC}$, $I_{O(LAMP)} = 5mA_{RMS}$		90		%

LINFINITY MICROELECTRONICS

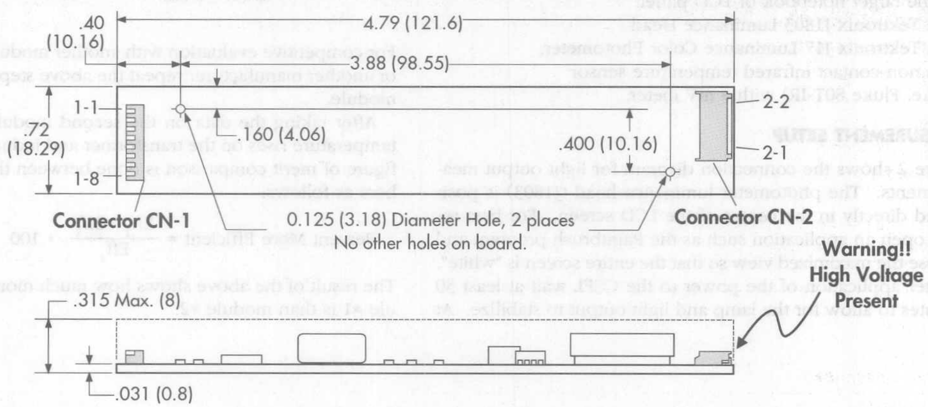
5V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+4.5 to +7V_{DC})
CN1-3 CN1-4	GND	Power supply return.
CN1-5	$\overline{SLEEP}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{SLEEP}$ through a 33kΩ resistor to V_{IN} or directly to any voltage between 2.5 and 5.5V. May be used to modulate lamp intensity by varying duty cycle.
CN1-6	BRITE	Brightness control input. Apply 0.8 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. 2.5V gives maximum brightness.
CN1-7	AGND	Brightness control signal return. For best results do not run 5V power supply current return through this pin.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.
CN2-2	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.

MECHANICAL OUTLINE



All dimensions in inches (mm)

Connectors:

CN-1 = MOLEX 53261-0890

CN-2 = JST SM02(8.0) B-BHS-TB

Recommended Mate:

Pins: 50079-8100*, Housing: 51021-0800

* Loose (-8000, Chain) Recommended #26 AWG wiring

Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

Note: All samples are equipped with connector mates and cable.

LINFINITY MICROELECTRONICS

CONNECTION DIAGRAM

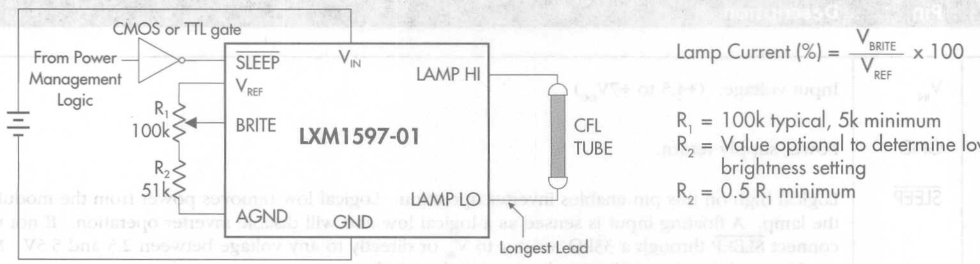


FIGURE 1 — RECOMMENDED CONNECTION DIAGRAM

EFFICIENCY MEASUREMENT SETUP

INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

EQUIPMENT REQUIRED

1) Two DVM's with 0.1% or better accuracy.
2) A lab power supply. (0 - 20V, 0 - 2A)
3) The target notebook or LCD panel.
4) A Tektronix J1803 Luminance Head.
5) A Tektronix J17 Luminance Color Photometer.
6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At the end of the 30 minute period read the light output in cd/m² (1 cd/m² = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$\text{Eff} = \frac{\text{Light Output (in Nits)}}{V_{IN\,(DC)} * I_{IN\,(DC)}} = \frac{\text{Nits}}{\text{Watt}}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

$$\text{Percent More Efficient} = \frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} * 100$$

The result of the above shows how much more efficient module #1 is than module #2.

LINFINITY MICROELECTRONICS

EFFICIENCY MEASUREMENT SETUP (continued)

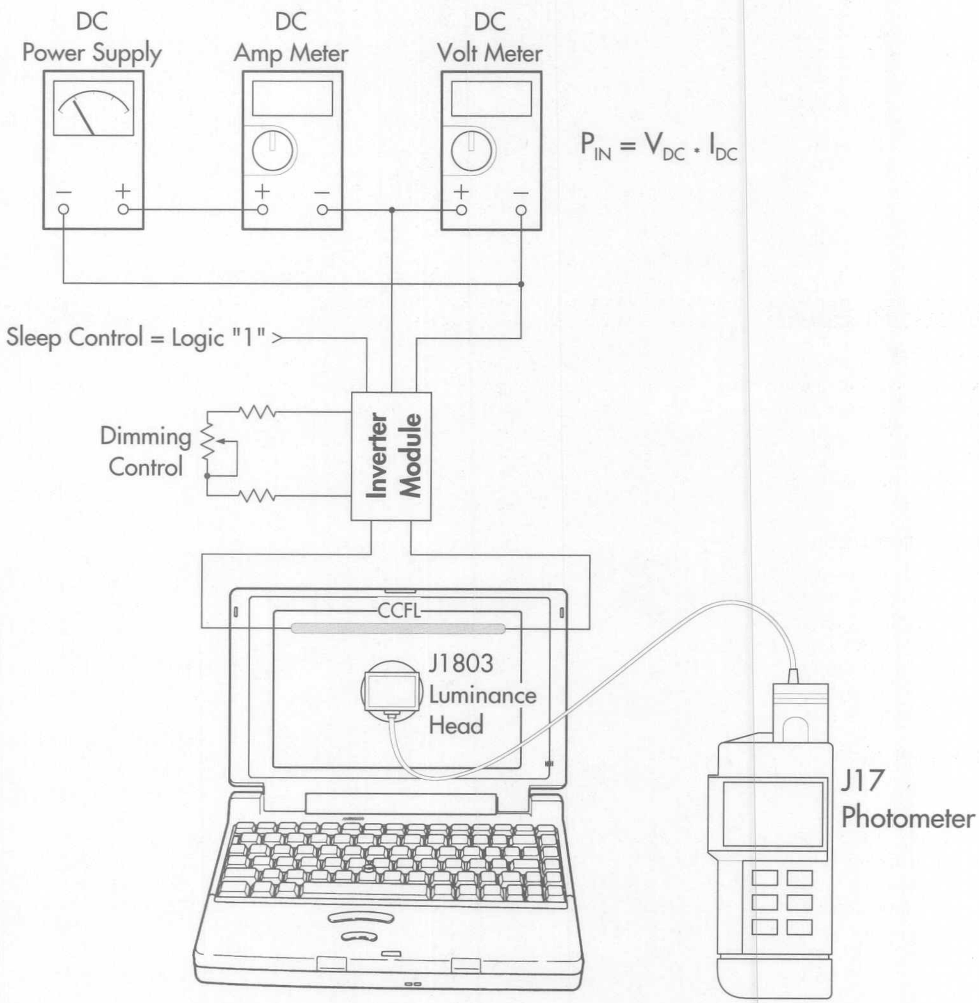


FIGURE 2 — LIGHT OUTPUT MEASUREMENT SETUP

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1598-01

12V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

DESCRIPTION

LXM1598-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultrahigh efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, high-voltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its *single* stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one pair of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The half bridge LXM1598-01 is optimized to efficiently operate with up to 4 watt lamps over the full 10V to 14V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

KEY FEATURES

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 10V TO 14V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINT

APPLICATIONS

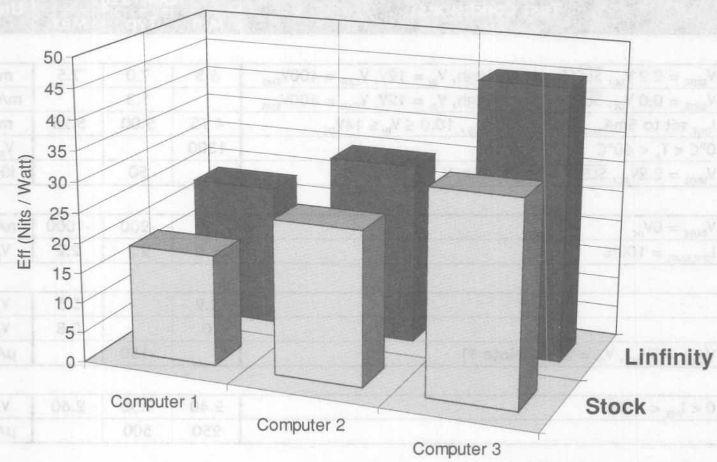
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD ENCLOSURES

PRODUCT HIGHLIGHT

BACKLIGHT INVERTER LIGHT OUTPUT EFFICIENCY COMPARISON



MODULE ORDER INFORMATION

10V - 14V INPUT
LXM1598-01

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LXM1598-01

12V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN})	-0.3V to 20V
Output Voltage, no load	Internally Limited to $1900V_{RMS}$
Output Current	$8.0mA_{RMS}$ (Internally Limited)
Output Power	4.2W
Input Signal Voltage, ($\overline{SLEEP}$ and BRITE Inputs)	-0.3V to 6.5V
Ambient Operating Temperature, zero airflow	0°C to 60°C
Storage Temperature Range	-40°C to 85°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

RECOMMENDED OPERATING CONDITIONS (R.C.)

*This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the '**R.C.**' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.*

Parameter	Symbol	Recommended Operating Conditions Min.	R.C.	Max.	Units
Input Supply Voltage	V_{IN}	10	12	14	V
Output Power	P_O		2.5	4.0	W
Brightness Control Input Voltage Range	V_{BRITE}	0.0		2.2	V
Lamp Operating Voltage	V_{LAMP}	240	500	650	V_{RMS}
Lamp Current - Full Brightness	I_{OLAMP}		5	7	mA_{RMS}
Operating Ambient Temperature Range	T_A	0		60	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1598.

Parameter	Symbol	Test Conditions	LXM1598 Min.	Typ.	Max.	Units
Output Pin Characteristics						
Full Bright Lamp Current	$I_{L\,(MAX)}$	$V_{BRITE} = 2.2\ V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 12V$, $V_{OUT} = 400V_{RMS}$	6.5	7.0	7.5	mA
Minimum Lamp Current	$I_{L\,(MIN)}$	$V_{BRITE} = 0.0\ V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 12V$, $V_{OUT} = 400V_{RMS}$		1.3		mA_{RMS}
I_{OUT} Regulation vs. V_{IN}		I_{OUT} set to $5mA_{RMS}$, $V_{OUT} = 400V_{RMS}$, $10.0 \le V_{IN} \le 14V_{DC}$	4.75	5.00	5.25	mA
Lamp Start Voltage	V_{LS}	$0°C < T_A < 60°C$	1300			V_{RMS}
Operating Frequency	f_O	$V_{BRITE} = 2.2V_{DC}$, $\overline{SLEEP}$ = Logic High, $V_{IN} = 12V$		50		KHz
Brightness Control						
Input Current	I_{BRITE}	$V_{BRITE} = 0V_{DC}$		-200	-1000	nA_{DC}
Input Voltage for Max. Lamp Current	V_C	$I_{O\,(LAMP)} = 100\%$	2.0	2.1	2.2	V_{DC}
$\overline{SLEEP}$ Input						
Input Logic 1	V_{IH}		2.2		5.5	V_{DC}
Input Logc 0	V_{IL}		0		0.8	V_{DC}
Input Current	I_{IN}	$V_{\overline{SLEEP}} = 5V_{DC}$, $V_{IN} = 20V_{DC}$ (Note 1)		-150		μA_{DC}
Voltage Reference						
Output Voltage	V_{REF}	$0 < I_{REF} < 500\mu A$	2.40	2.50	2.60	V_{DC}
Output Current	I_{REF}		250	500		μA_{DC}
Power Characteristics						
Sleep Current	$I_{IN\,(MIN)}$	$V_{IN} = 5V_{DC}$, $\overline{SLEEP}$ = Logic 0		3	10	μA_{DC}
Electrical Efficiency (calculated values)	η	$V_{IN} = 12V_{DC}$, $I_{O\,(LAMP)} = 5mA_{RMS}$		90		%

Note 1: $\overline{SLEEP}$ pin is pulled up to V_{IN} through a 100kΩ resistor and is clamped to not exceed $10V_{DC}$ if $V_{IN} > 10V_{DC}$.

LINFINITY MICROELECTRONICS

PATENT PENDING

LXM1598-01

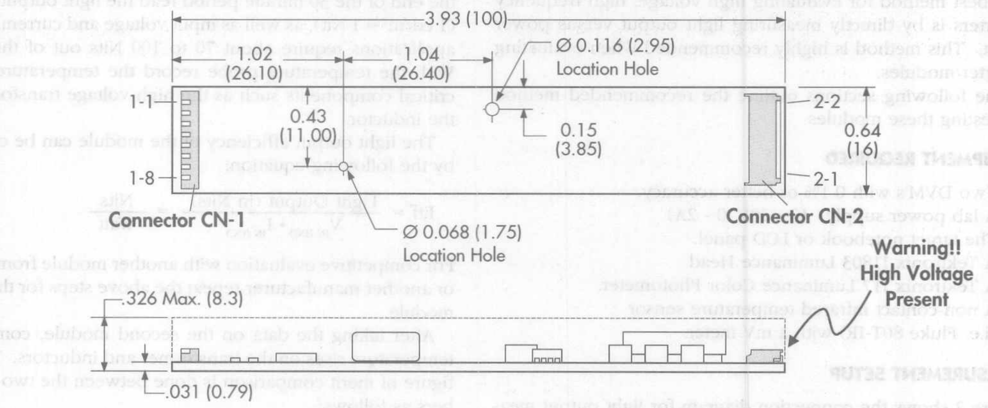
12V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

FUNCTIONAL PIN DESCRIPTION

Conn.	Pin	Description
CN1		
CN1-1 CN1-2	V_{IN}	Input voltage. (+10 to +14V_{DC})
CN1-3 CN1-4	GND	Power supply return.
CN1-5	$\overline{\text{SLEEP}}$	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical high and will enable inverter operation. May be used to modulate lamp intensity by varying duty cycle.
CN1-6	BRITE	Brightness control input. Apply 0.0 to 2.2 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. Open circuit or 2.2V gives maximum brightness.
CN1-7	AGND	Brightness control signal return. For best results do not run power supply current return through this pin.
CN1-8	V_{REF}	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2		
CN2-1	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.
CN2-2	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.

MECHANICAL OUTLINE



All dimensions in inches (mm)

Connectors:	**Recommended Mate:**
CN-1 = MOLEX 53261-0890	Pins: 50079-8100*, Housing: 51021-0800 * Loose (-8000, Chain) Recommended #26 AWG wiring
CN-2 = JST SM02(8.0) B-BHS-TB	Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

Note: All samples are equipped with connector mates and cable.

LINFINITY MICROELECTRONICS

LXM1598-01

12V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

CONNECTION DIAGRAM

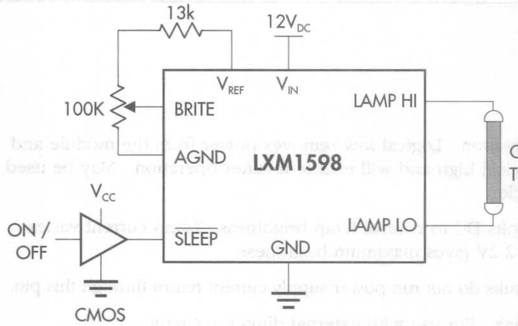


FIGURE 1 — POTENTIOMETER BRIGHTNESS CONTROL

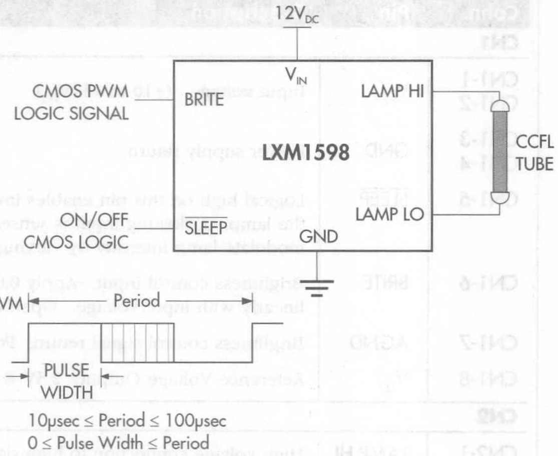


FIGURE 2 — PWM BRIGHTNESS CONTROL

EFFICIENCY MEASUREMENT SETUP

INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

EQUIPMENT REQUIRED

1) Two DVM's with 0.1% or better accuracy.
2) A lab power supply. (0 - 20V, 0 - 2A)
3) The target notebook or LCD panel.
4) A Tektronix J1803 Luminance Head.
5) A Tektronix J17 Luminance Color Photometer.
6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At the end of the 30 minute period read the light output in cd/m^2 ($1\ cd/m^2 = 1$ Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$\text{Eff} = \frac{\text{Light Output (in Nits)}}{V_{IN\ (DC)} \cdot I_{IN\ (DC)}} = \frac{\text{Nits}}{\text{Watt}}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

$$\text{Percent More Efficient} = \frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} \cdot 100$$

The result of the above shows how much more efficient module #1 is than module #2.

LINFINITY MICROELECTRONICS

EFFICIENCY MEASUREMENT SETUP (continued)

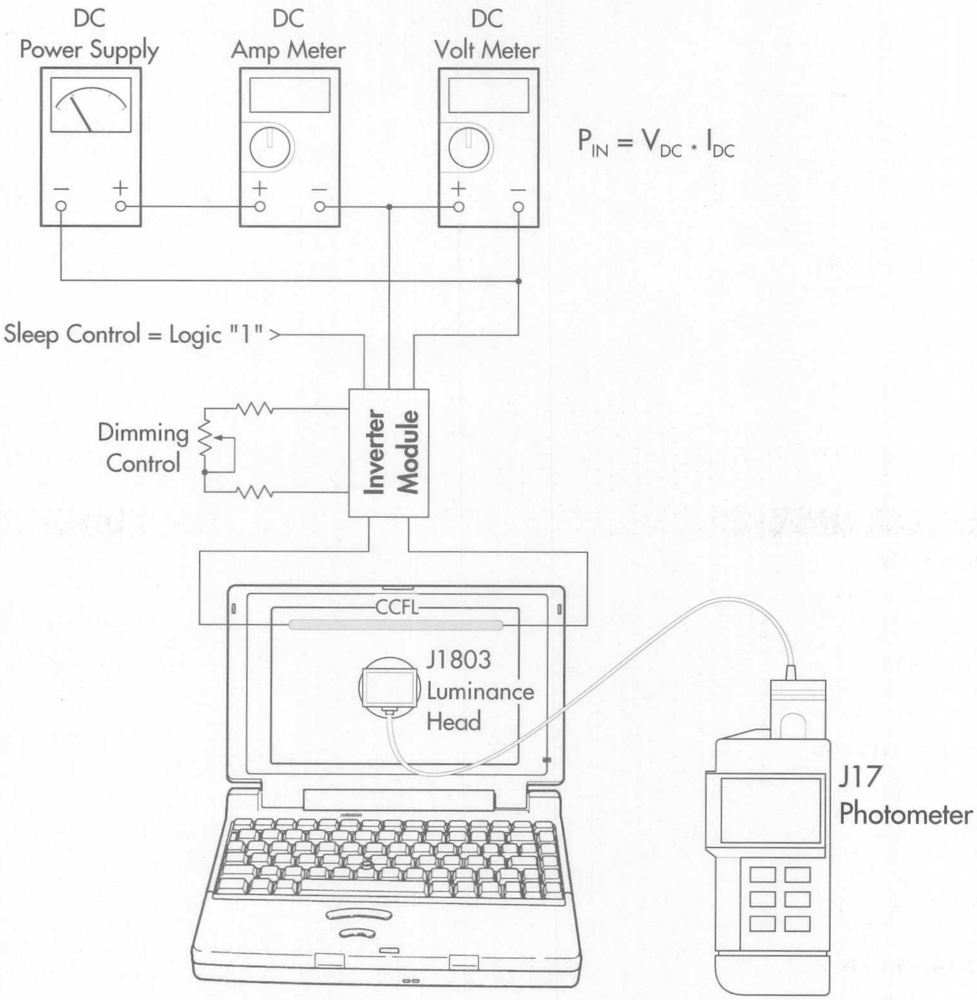


FIGURE 2 — LIGHT OUTPUT MEASUREMENT SETUP

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LXM1600/1600A-xx

PENTIUM® PRO VRM MODULE

PRELIMINARY SPECIFICATION

DESCRIPTION

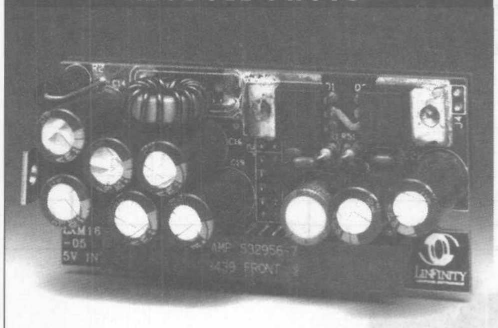
The LXM1600/1600A-xx series of DC/DC converters are Voltage Regulator Modules (VRM) which are specifically designed to meet or exceed the Pentium Pro VRM electrical specification as well as its mechanical outline. The LXM1600-xx is guaranteed to deliver a minimum current of 11.2A while the LXM1600A-xx is capable of 12.4A for higher speed processor applications. These converters maintain a total tolerance of ±5% maximum, which includes load and line regulation, temperature stability, inital accuracy, load transient and ripple and noise. One of the main features of these converters is their ability to program the output voltage from 2 to 3.5V using a 4-bit word from the processors, providing automatic voltage adjustment for each individual processor. Other features include high efficiency, short-circuit protection, over-voltage protection, under-voltage detection, soft start and logic level output enable functions.

The LXM1600/1600A-05 powers the processor using the 5V supply as the input power and 12V for the control bias. The LXM1600/1600A-12 powers the processor using only the 12V supply and does not need a separate voltage for the control bias (see Block Diagram below). The LXM1600A-12 is primarily used for multiple processor applications, such as quad processor servers, where 5V supplies may not have the needed current capability.

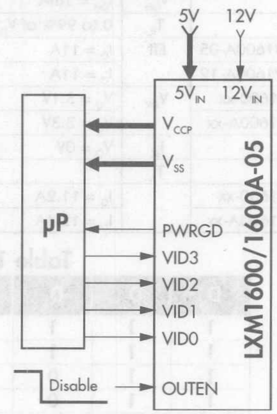
KEY FEATURES

- **GUARANTEED > 12.4A (LXM1600A-xx)**
- **GUARANTEED > 11.2A (LXM1600-xx)**
- TOTAL OUTPUT TOLERANCE OF LESS THAN ±5%
  Includes: Line & load regulation, temperature stability, initial accuracy, load transient and ripple & noise.
- ADJUSTABLE OUTPUT VOLTAGE USING A FOUR-BIT WORD (See Table 1)
- OVER-VOLTAGE DETECTION CROWBARS THE OUTPUT VOLTAGE IN THE EVENT OF PASS TRANSISTOR FAILURE - 100% PROCESSOR PROTECTION
- HIGH EFFICIENCY — 85% (TYP.)
- POWER GOOD SIGNAL INDICATES LOW OUTPUT VOLTAGE
- SOFT START ELIMINATES TURN ON OVERSHOOT
- SHORT-CIRCUIT PROTECTION
- OUTPUT ENABLE /SHUTDOWN

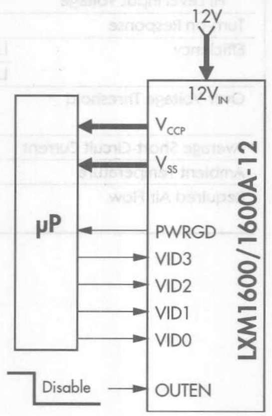
MODULE PHOTO



BLOCK DIAGRAM



LXM1600/1600A-05
IN A 5V SUPPLY APPLICATION



LXM1600/1600A-12
IN A 12V SUPPLY APPLICATION

MODULE ORDER INFORMATION

Part #	Input	I_{MAX}
LXM1600-05	5V	11.2A
LXM1600A-05	5V	12.4A
LXM1600-12	12V	11.2A
LXM1600A-12	12V	12.4A

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Test Conditions	LXM1600/1600A-xx Min.	Typ.	Max.	Units
Input Voltage	LXM1600/1600A-05	V_{IN}		4.75	5	5.25	V
	LXM1600/1600A-12			11.4	12	12.6	V
Total Output Voltage Tolerance	LXM1600-xx	V_O		2.945	3.1	3.255	V
	LXM1600A-xx			3.135	3.3	3.465	V
Includes: Initial Accuracy			$I_O = 0.3A$, $T_A = 25°C$		±0.6		%
Load Regulation	LXM1600-xx		$I_O = 0.3A$ to 11.2A		15		mV
	LXM1600A-xx		$I_O = 0.3A$ to 12.4A		15		mV
Line Regulation			$0.95V_{IN}$ to $1.05V_{IN}$		1		mV
Temp. Stability			10 to 60°C		16		mV
Load Transient	LXM1600-xx		$I_O = 0.3A$ to 11.2A, $V_{IN} = 5V$		90		mV
	LXM1600A-xx		$I_O = 0.3A$ to 12.4A, $V_{IN} = 5V$		95		mV
Output Ripple & Noise			$I_O = 5A$		12		mV
Output Current	Max. 1600-xx	I_O	$V_O = 3.1V$	11.2	11.8		A
	Max. 1600A-xx		$V_O = 3.1V$	12.4	12.6		A
	Minimum					0	A
Power Good Threshold		V_{THPG}			$0.93V_{SET}$		V
Power Good Output LO Resistance		R_{LOPG}	OUTEN = LO		5		Ω
Output Enable		OUTEN					
LO Level Input Voltage		V_{OL}	$I_{OL} = 1mA$			0.8	V
HI Level Input Voltage		V_{OH}	$I_{OH} = 1mA$	2			V
Turn-on Response		T_R	0 to 99% of V_O after V_{IN} reaches 90%			10	ms
Efficiency	LXM1600/1600A-05	Eff	$I_O = 11A$		85		%
	LXM1600/1600A-12		$I_O = 11A$		80		%
Over-Voltage Threshold	LXM1600-xx	V_{OV}	$V_O = 3.1V$		3.66		V
	LXM1600A-xx		$V_O = 3.3V$		3.85		V
Average Short-Circuit Current		I_{SC}	$V_O = 0V$		2		A
Ambient Temperature		T_A		0		60	°C
Required Air Flow	LXM1600-xx		$I_O = 11.2A$	100			LFM
	LXM1600A-xx		$I_O = 12.4A$	200			LFM

Table 1

D_3	D_2	D_1	D_0	V_{SET} (V)
1	1	1	1	2
1	1	1	0	2.1
1	1	0	1	2.2
1	1	0	0	2.3
1	0	1	1	2.4
1	0	1	0	2.5
1	0	0	1	2.6
1	0	0	0	2.7
0	1	1	1	2.8
0	1	1	0	2.9
0	1	0	1	3.0
0	1	0	0	3.1
0	0	1	1	3.2
0	0	1	0	3.3
0	0	0	1	3.4
0	0	0	0	3.5

- Note: 0 ≡ Processor pin connected to ground.
1 ≡ Processor pin Open or pulled High externally by system design to detect a socket with no processor.

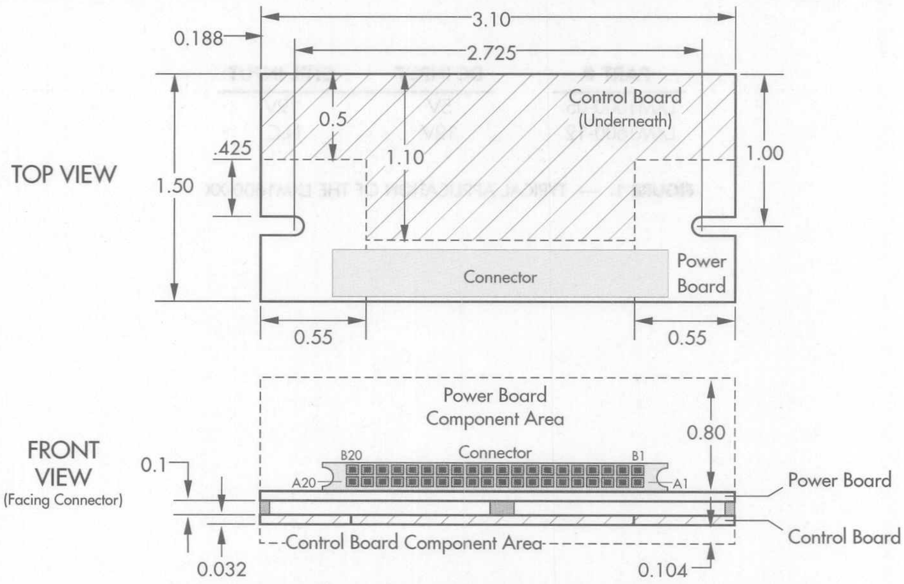
LINFINITY MICROELECTRONICS

CONNECTOR PIN-OUTS AND DESCRIPTIONS

Pin #	Ref. Desig.	Description
A1	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
A2	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
A3	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
A4	$12V_{IN}$	12V Input Power
A5	Reserved	This pin is reserved for future applications
A6	Reserved	This pin is reserved for future applications
A7	VID0	Bit 0 of the 4-bit input (see Table 1)
A8	VID2	Bit 2 of the 4-bit input (see Table 1)
A9	UP#	This pin is not connected internally
A10	V_{CCP}	Output voltage to microprocessor
A11	V_{SS}	Output voltage return
A12	V_{CCP}	Output voltage to microprocessor
A13	V_{SS}	Output voltage return
A14	V_{CCP}	Output voltage to microprocessor
A15	V_{SS}	Output voltage return
A16	V_{CCP}	Output voltage to microprocessor
A17	V_{SS}	Output voltage return
A18	V_{CCP}	Output voltage to microprocessor
A19	V_{SS}	Output voltage return
A20	V_{CCP}	Output voltage to microprocessor

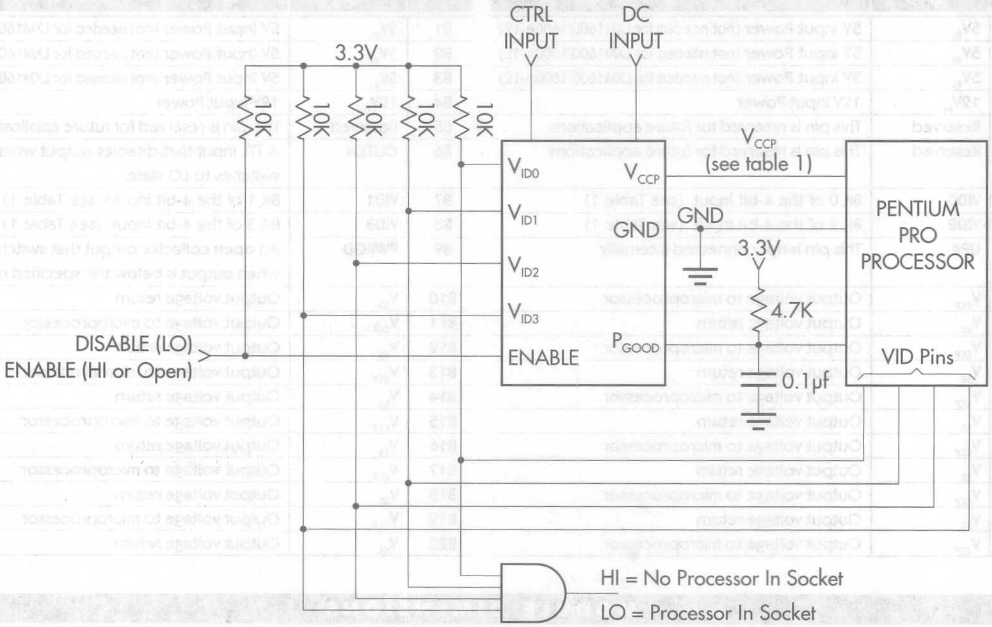
Pin #	Ref. Desig.	Description
B1	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
B2	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
B3	$5V_{IN}$	5V Input Power (not needed for LXM1600/1600A-12)
B4	$12V_{IN}$	12V Input Power
B5	Reserved	This pin is reserved for future applications
B6	OUTEN	A TTL input that disables output when it switches to LO state
B7	VID1	Bit 1 of the 4-bit input (see Table 1)
B8	VID3	Bit 3 of the 4-bit input (see Table 1)
B9	PWRGD	An open collector output that switches LO when output is below the specified range
B10	V_{SS}	Output voltage return
B11	V_{CCP}	Output voltage to microprocessor
B12	V_{SS}	Output voltage return
B13	V_{CCP}	Output voltage to microprocessor
B14	V_{SS}	Output voltage return
B15	V_{CCP}	Output voltage to microprocessor
B16	V_{SS}	Output voltage return
B17	V_{CCP}	Output voltage to microprocessor
B18	V_{SS}	Output voltage return
B19	V_{CCP}	Output voltage to microprocessor
B20	V_{SS}	Output voltage return

MODULE DIMENSIONS



LINFINITY MICROELECTRONICS

APPLICATION INFORMATION



PART #	DC INPUT	CTRL INPUT
LXM1600-05	5V	12V
LXM1600-12	12V	N.C.

FIGURE 1. — TYPICAL APPLICATION OF THE LXM1600-XX

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

MC33064/MC34064

UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

DESCRIPTION

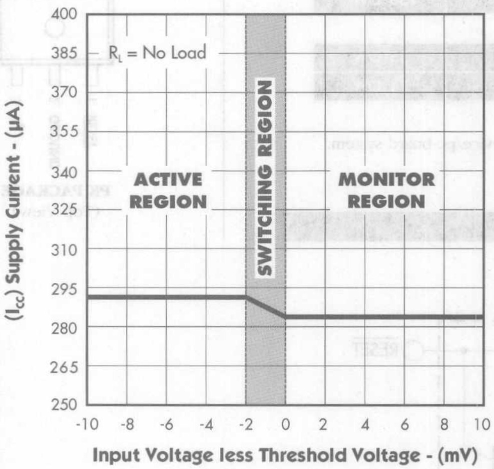
The MC34064 is an undervoltage sensing circuit designed specifically for use as a reset controller in microprocessor-based systems. It offers the designer an economical, space-efficient solution for low supply voltage detection when used in combination with a single pull-up resistor. Adding one capacitor offers the functionality of a programmable delay time after power returns. The 34064 consists of a temperature stable reference comparator with hysteresis, high-current clamping diode and open collector output stage capable of sinking up to 60mA. The MC34064's $\overline{\text{RESET}}$ output is specified to be fully functional at V_{IN}=1V. A major improvement over competing products is the glitch-free supply current during undervoltage detection. Competing products demand a step function increase in operating current during the time that you least want or need it.... during power loss. See Product Highlight below.

KEY FEATURES

- **MONITORS 5V SUPPLIES.** (V_T = 4.6V typ)
- **OUTPUTS FULLY DEFINED AT V_{IN} = 1V.** (See Figure 1)
- **GLITCH-FREE SUPPLY CURRENT DURING SWITCHING.** (See Product Highlight)
- ULTRA-LOW SUPPLY CURRENT (500µA max)
- TEMPERATURE COMPENSATED I_{CC} FOR EXTREMELY STABLE CURRENT CONSUMPTION.
- µP RESET FUNCTION PROGRAMMABLE WITH 1 EXTERNAL RESISTOR AND CAPACITOR.
- COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION.
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34064.
- PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064/MC34164.

PRODUCT HIGHLIGHT

SUPPLY CURRENT VS. INPUT VOLTAGE



APPLICATIONS

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 5V SUPPLIES.
- SIMPLE 5V UNDERVOLTAGE DETECTION.

PACKAGE ORDER INFORMATION

T_A (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	MC34064DM	MC34064LP	MC34064PK
-40 to 85	MC33064DM	MC33064LP	MC33064PK
-55 to 125	—	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. MC34064DMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

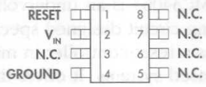
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

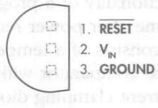
Input Supply Voltage (V_{IN}) .... -1V to 10V
$\overline{RESET}$ Output Voltage (V_{OUT}) 10V
Output Sink Current (I_{OL}) .... Internally Limited (mA)
Clamp Diode Forward Current (I_F), Pin 1 to pin 2 .... 100mA
Operating Junction Temperature
Plastic (DM, LP, PK - Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

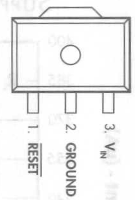
PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)



PK PACKAGE
(Top View)

THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

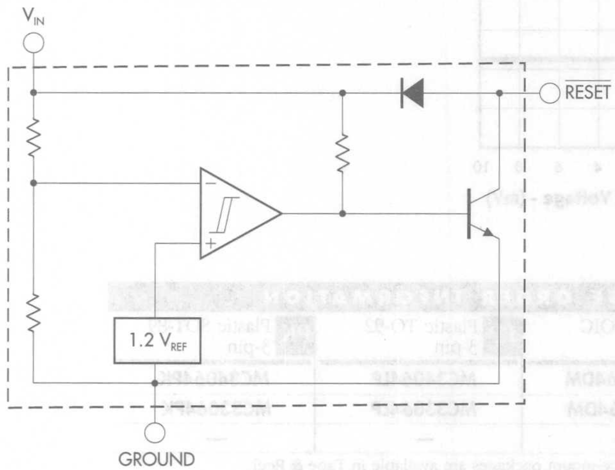
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

PK PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	71°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

MC33064/MC34064

UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Supply Voltage	V_{IN}	1		6.5	V
$\overline{\text{RESET}}$ Output Voltage	V_{OUT}		6.5		V
Clamp Diode Forward Current	I_F		50mA		
Operating Ambient Temperature Range:					
MC34064	T_A	0		70	°C
MC33064	T_A	-40		85	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C for the MC34064 and -40°C ≤ T_A ≤ 85°C for the MC33064. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	MC34064/MC33064 Min.	Typ.	Max.	Units
Comparator Section						
Threshold Voltage						
High State Output	V_{T+}	V_{IN} Increasing — 4V to 5V	4.5	4.61	4.7	V
Low State Output	V_{T-}	V_{IN} Decreasing — 5V to 4V	4.5	4.59	4.7	V
Hysteresis	V_H		0.01	0.02	0.05	V
$\overline{\text{RESET}}$ Output Section						
Output Low Level Saturation Voltage	V_{OL}	V_{IN} = 4.0V, I_{OL} = 8.0mA			1.0	V
		V_{IN} = 4.0V, I_{OL} = 2.0mA			0.4	V
		V_{IN} = 1.0V, I_{OL} = 0.1mA			0.1	V
Output Low Level Current	I_{OL}	V_{IN} = V_{OUT} = 4.0V	10	27	60	mA
Output Off-State Leakage	I_{OH}	V_{IN} = V_{OUT} = 5.0V		0.02	0.5	µA
Clamp Diode Forward Voltage	V_F	Pin 1 to pin 2, I_F = 10mA	0.6	0.9	1.2	V
Total Device						
Supply Current	I_{CC}	V_{IN} = 5.0V		390	500	µA

LINFINITY MICROELECTRONICS

MC33064/MC34064

Transient Immune Undervoltage Sensing Circuit

Production Data Sheet

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Circuits

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — INPUT VOLTAGE and RESET OUTPUT VOLTAGE vs. TIME

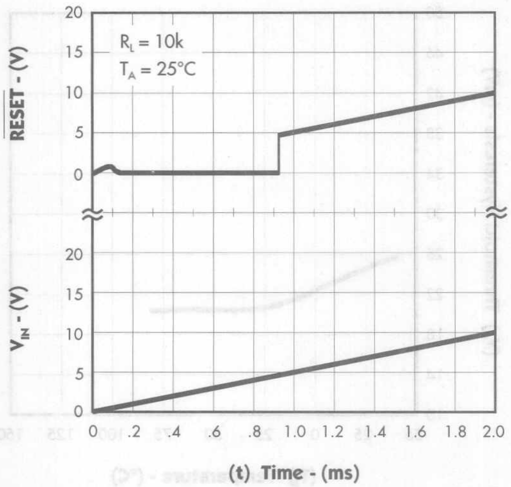


FIGURE 2. — POWER-UP RESET VOLTAGE

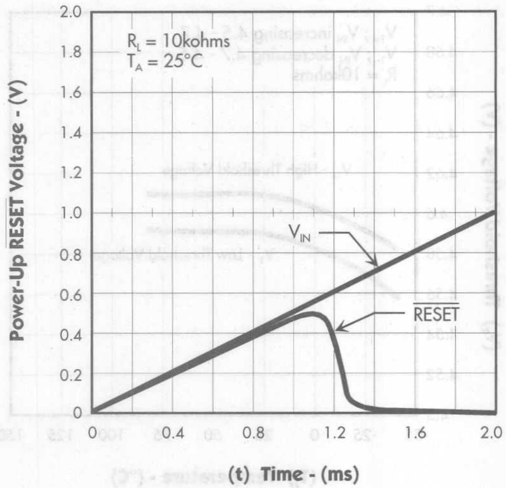


FIGURE 3. — POWER-DOWN RESET VOLTAGE

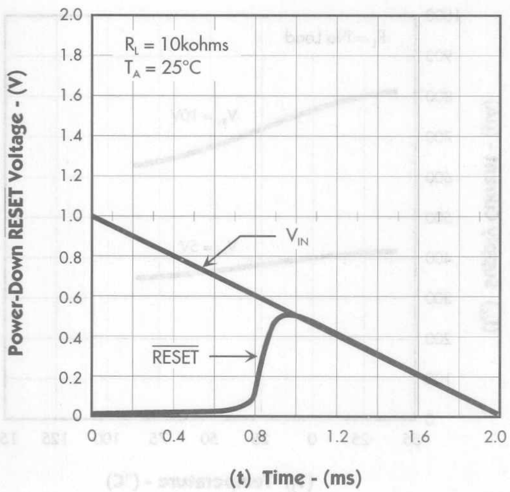
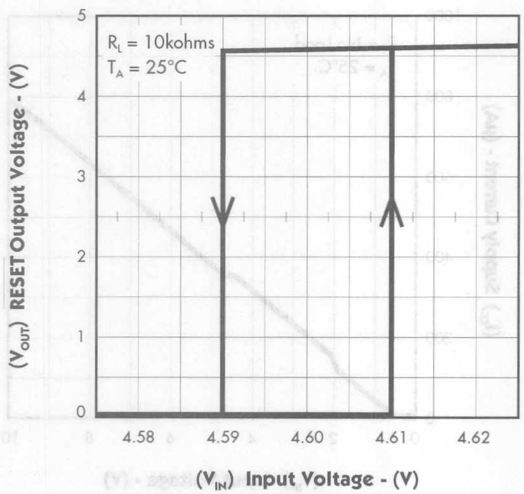


FIGURE 4. — RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — THRESHOLD VOLTAGE vs. TEMPERATURE

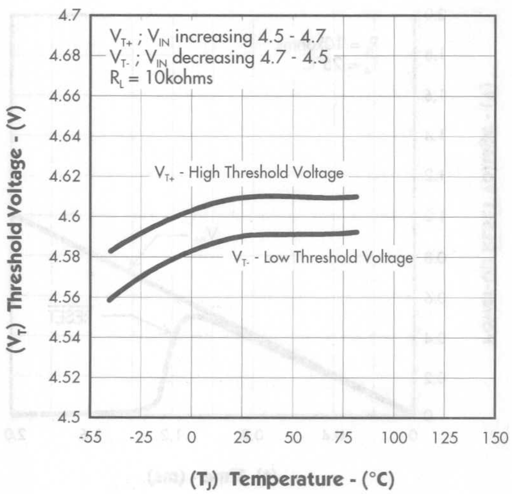


FIGURE 6. — THRESHOLD HYSTERESIS vs. TEMPERATURE

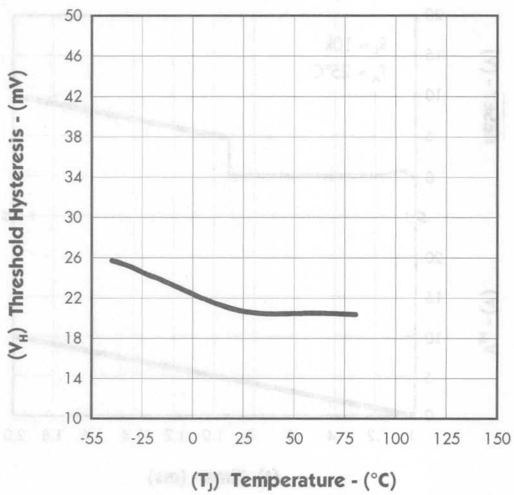


FIGURE 7. — SUPPLY CURRENT vs. INPUT VOLTAGE

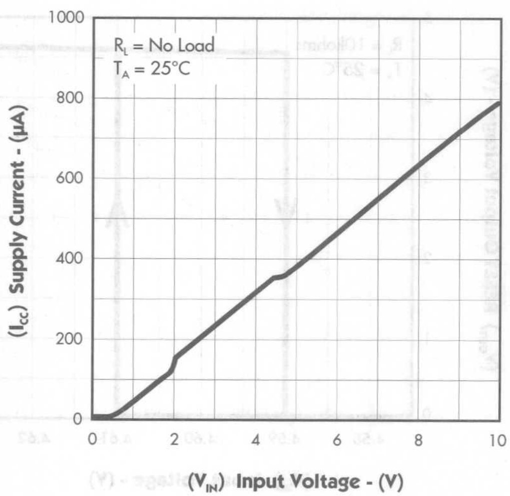
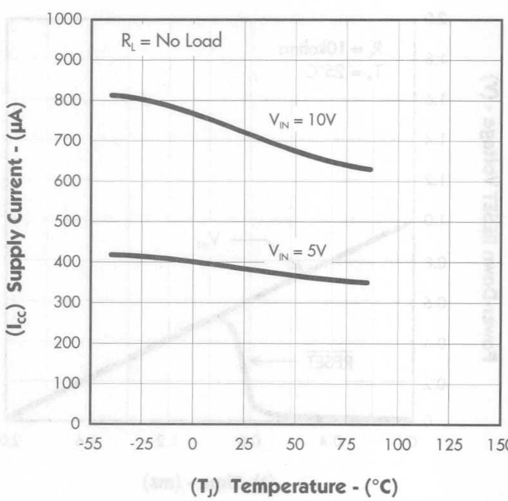


FIGURE 8. — SUPPLY CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 9. — LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE

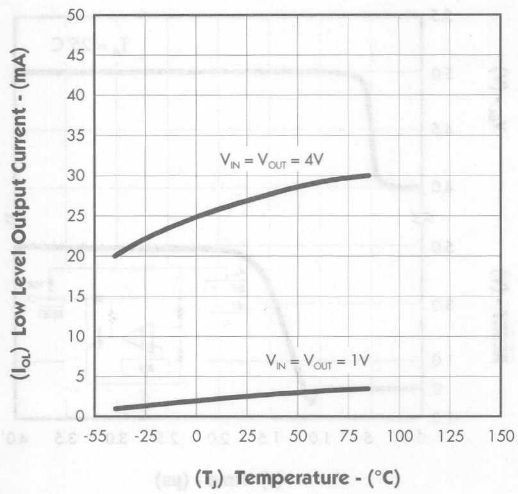


FIGURE 10. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

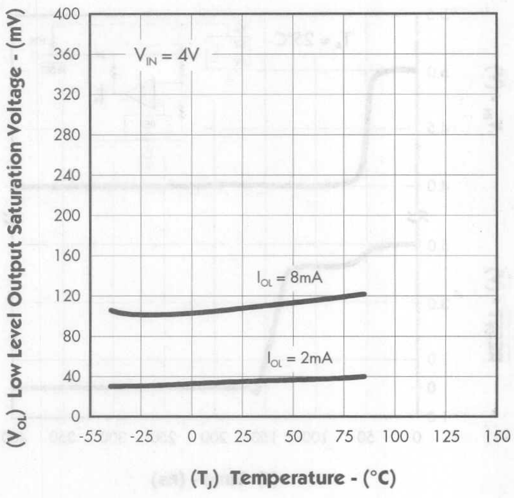


FIGURE 11. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

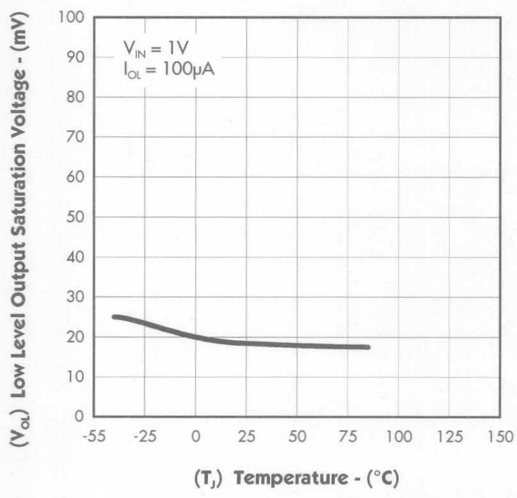
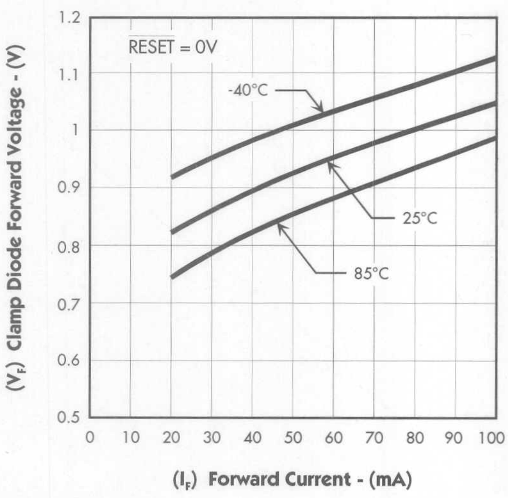


FIGURE 12. — CLAMP DIODE FORWARD VOLTAGE vs. FORWARD CURRENT



CHARACTERISTIC CURVES

FIGURE 13. — PROPAGATION DELAY — HIGH to LOW

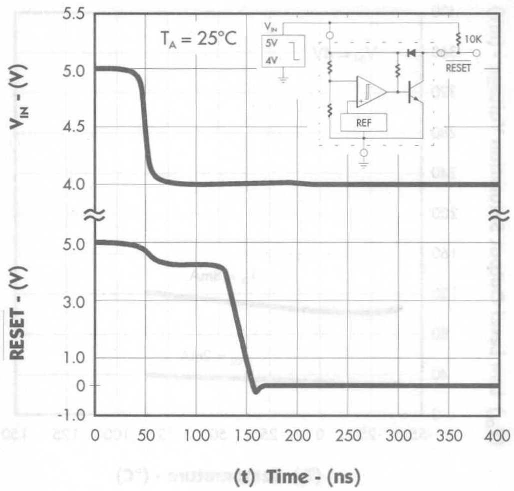
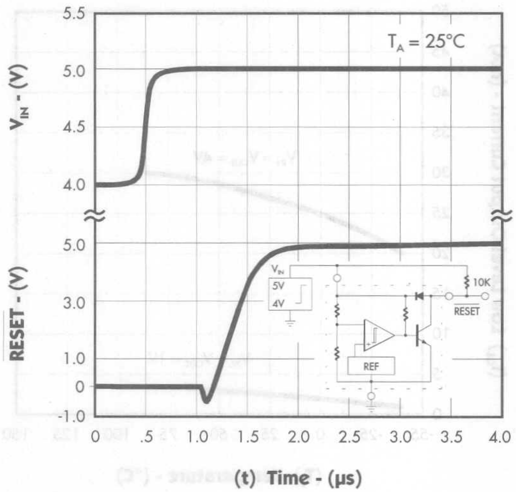


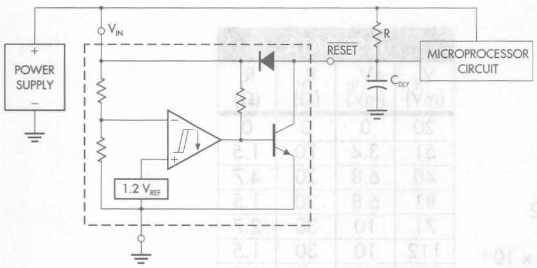
FIGURE 14. — PROPAGATION DELAY — LOW to HIGH



LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

FIGURE 15. — LOW VOLTAGE MICROPROCESSOR RESET



A time delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC_{DLY} time constant be greater than 5.0µs. $V_{TH(MPU)}$ is the microprocessor reset input threshold.

$$t_{DLY} = R\, C_{DLY} \ln\left[\frac{1}{1-\frac{V_{TH(MPU)}}{V_{IN}}}\right]$$

FIGURE 16. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V

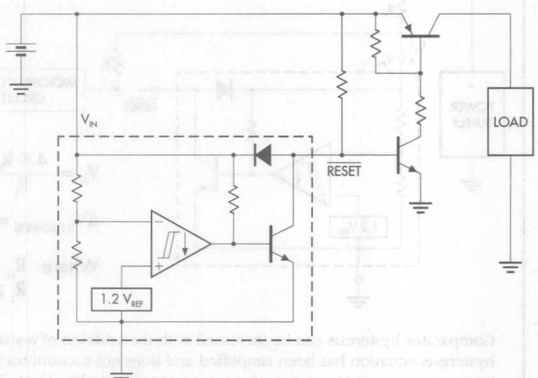


FIGURE 17. — VOLTAGE MONITOR

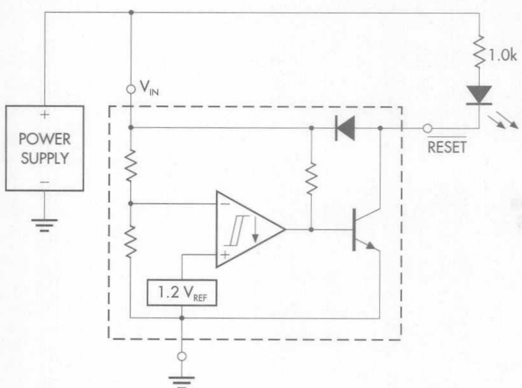
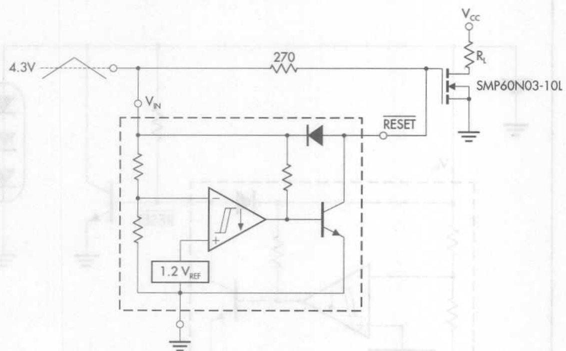


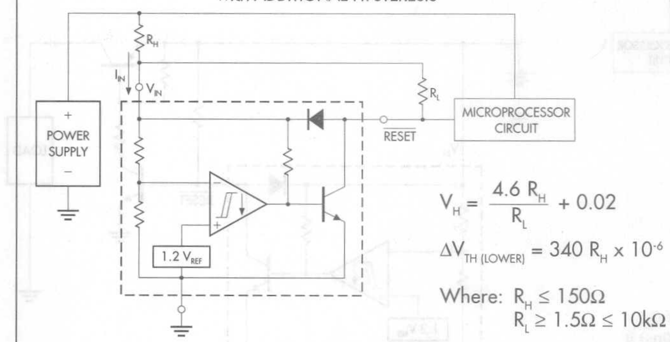
FIGURE 18. — MOSFET LOW VOLTAGE GATE DRIVE PROTECTION



Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.6 volt threshold of the MC34064, its output grounds the gate of the L^2 MOSFET.

TYPICAL APPLICATION CIRCUITS (Cont'd.)

FIGURE 19. — LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS



$$V_H = \frac{4.6\ R_H}{R_L} + 0.02$$

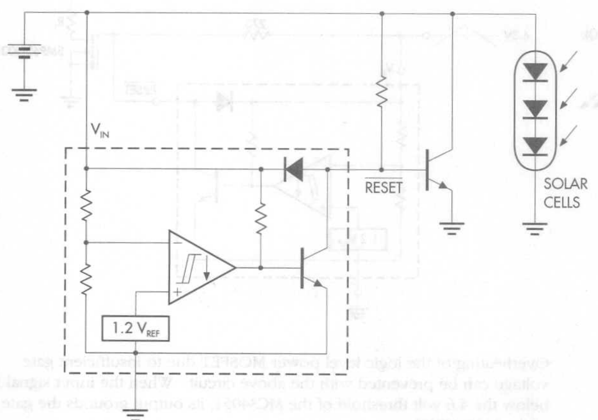
$$\Delta V_{TH\ (LOWER)} = 340\ R_H \times 10^{-6}$$

Where: $R_H \leq 150\Omega$
$R_L \geq 1.5\Omega \leq 10k\Omega$

TEST DATA			
V_H (mV)	ΔV_{TH} (mV)	R_H (Ω)	R_L (Ω)
20	0	0	0
51	3.4	10	1.5
40	6.8	20	4.7
81	6.8	20	1.5
71	10	30	2.7
112	10	30	1.5
100	16	47	2.7
164	16	47	1.5
190	34	100	2.7
327	34	100	1.5
276	51	150	2.7
480	51	150	1.5

Comparator hysteresis can be increased with the addition of resistor R_H. The hysteresis equation has been simplified and does not account for the change of input current I_{IN} as V_{CC} crosses the comparator threshold. An increase of the lower threshold $\Delta V_{TH\ (LOWER)}$ will be observed due to I_{IN} which is typically 340µA at 4.59V. The equations are accurate to ±10% with R_H less than 150Ω and R_L between 1.5kΩ and 10kΩ.

FIGURE 20. — SOLAR POWERED BATTERY CHARGER



LINFINITY MICROELECTRONICS

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

MC33164-3/MC34164-3

3V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

DESCRIPTION

The MC33164-3 and MC34164-3 are undervoltage sensing circuits designed specifically for use as reset controllers in microprocessor-based systems. They offer the designer an economical, space efficient solution for low supply voltage detection when used in combination with a single pull-up resistor. Adding one capacitor offers the functionality of a programmable delay time after power returns. The MC33164-3 and MC34164-3 consist of a temperature stable reference comparator with hysteresis, high-current clamping diode and an open collector output stage capable of sinking more than 6mA over the full temperature range. The MC33164-3 and MC34164-3's $\overline{\text{RESET}}$ output is specified to be fully functional at $V_{IN} \geq 1V$. See Product Highlight below.

KEY FEATURES

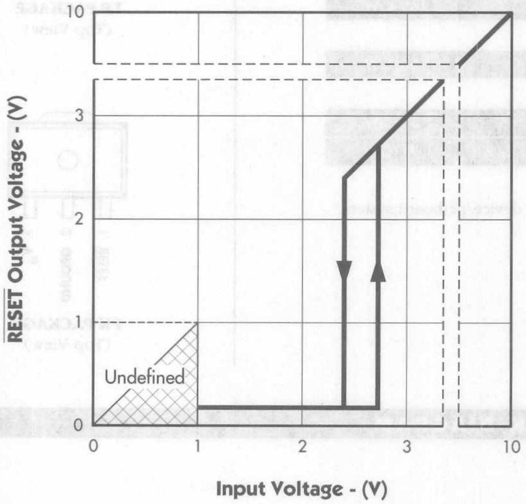
- **MONITORS +3.3V SUPPLIES** ($V_T = 2.7V$ typ)
- **OUTPUTS FULLY DEFINED AT $V_{IN} \geq 1V$** (See Product Highlight)
- **ULTRA-LOW SUPPLY CURRENT** (13µA max)
- TEMPERATURE COMPENSATED I_{CC} FOR EXTREMELY STABLE CURRENT CONSUMPTION
- µP RESET DELAY PROGRAMMABLE WITH 1 EXTERNAL RESISTOR AND CAPACITOR
- COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION (60mV typ.)
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34164-3
- PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064 / MC34164

APPLICATIONS

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 3V/3.3V SUPPLIES
- SIMPLE 3V/3.3 UNDERVOLTAGE DETECTION

PRODUCT HIGHLIGHT

$\overline{\text{RESET}}$ OUTPUT VS. INPUT VOLTAGE



PACKAGE ORDER INFORMATION

T_A (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	MC34164-3DM	MC34164-3LP	MC34164-3PK
-40 to 85	MC33164-3DM	MC33164-3LP	MC33164-3PK

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. MC34164-3DMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

MC33164-3/MC34164-3

3V Undervoltage Sensing Circuit

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V_{IN}) .... -1V to 12V
RESET Output Voltage (V_{OUT}) 12V
Output Sink Current (I_{OL}) .... Internally Limited (mA)
Clamp Diode Forward Current (I_F), Pin 1 to pin 2 .... 100mA
Operating Junction Temperature
Plastic (DM, LP, PK - Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

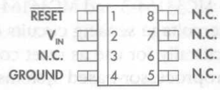
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

PK PACKAGE:

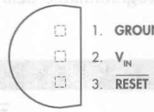
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	71°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

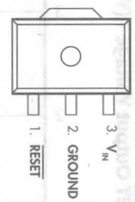
PACKAGE PIN OUTS



DM PACKAGE
(Top View)

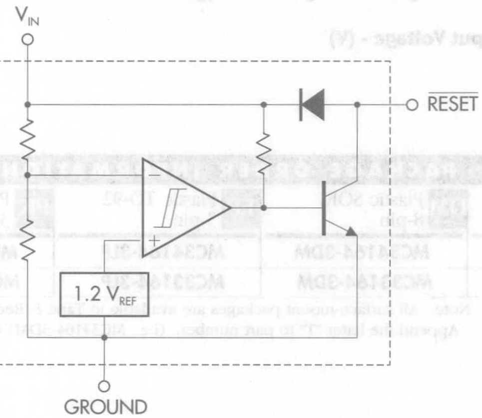


LP PACKAGE
(Top View)



PK PACKAGE
(Top View)

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

MC33164-3/MC34164-3

3V Undervoltage Sensing Circuit

Production Data Sheet

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Supply Voltage	V_{IN}	1		10	V
$\overline{RESET}$ Output Voltage	V_{OUT}	-0.3		10	V
Clamp Diode Forward Current (Note 3)	I_F			100	mA
Operating Ambient Temperature Range:					
MC34164-3	T_A	0		70	°C
MC33164-3	T_A	-40		85	°C

Note 2. Range over which the device is guaranteed functional.
Note 3. Maximum junction temperature ratings must be observed.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C for the MC34164-3 and -40°C ≤ T_A ≤ 85°C for the MC33164-3. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	MC33164-3 / 34164-3 Min.	Typ.	Max.	Units
Comparator Section						
Threshold Voltage						
High State Output	V_{T+}	V_{IN} Increasing — 2.4V to 3.5V	2.55	2.71	2.8	V
Low State Output	V_{T-}	V_{IN} Decreasing — 3.5V to 2.4V	2.55	2.65	2.8	V
Hysteresis	V_H	(I_{OL} = 100µA)	0.03	0.06		V
$\overline{RESET}$ Output Section						
Output Low Level Saturation Voltage	V_{OL}	V_{IN} = 2.4V, I_{OL} = 8.0mA		0.15	1.0	V
		V_{IN} = 2.4V, I_{OL} = 1.0mA		0.04	0.4	V
		V_{IN} = 1.0V, I_{OL} = 0.25mA		0.02	0.3	V
Output Low Level Current	I_{OL}	V_{IN} , $\overline{RESET}$ = 2.4V	6.0	24	40	mA
Output Off-State Leakage	I_{OH}	V_{IN} , $\overline{RESET}$ = 3.0V		.02	0.5	µA
		V_{IN} , $\overline{RESET}$ = 10V		.02	1.0	µA
Clamp Diode Forward Voltage	V_F	Pin 1 to pin 2, I_F = 5mA	0.6	0.75	1.0	V
Total Device						
Supply Current	I_{CC}	V_{IN} = 3.0V		9	13	µA
		V_{IN} = 6.0V		21	30	µA

LINFINITY MICROELECTRONICS

MC33164-3/MC34164-3

3V Undervoltage Sensing Circuit

PRODUCTION DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Circuits

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — INPUT VOLTAGE and $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. TIME

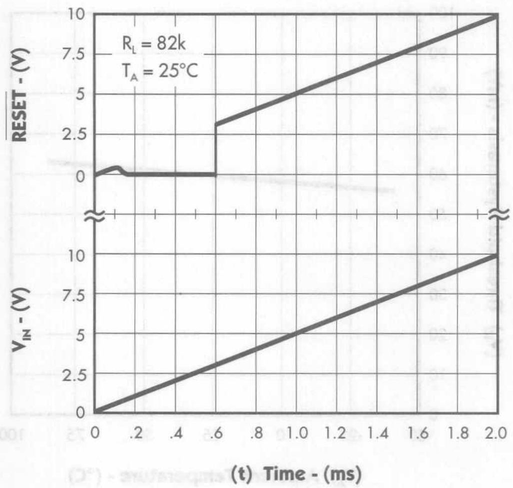


FIGURE 2. — POWER-UP $\overline{\text{RESET}}$ VOLTAGE

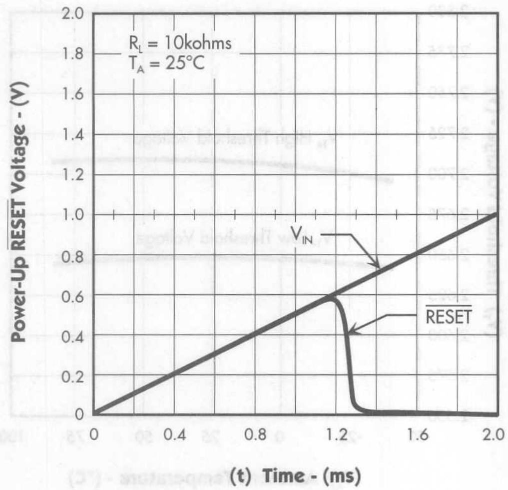


FIGURE 3. — POWER-DOWN $\overline{\text{RESET}}$ VOLTAGE

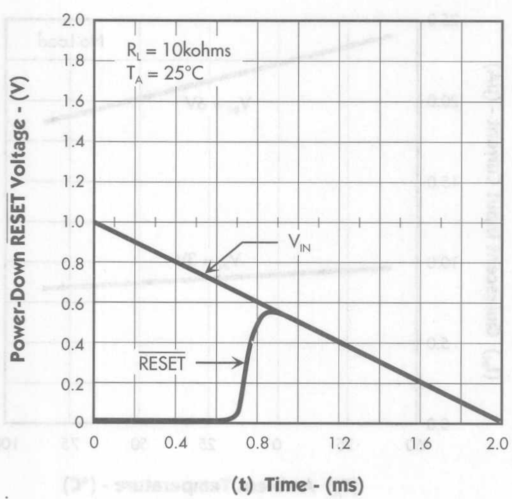
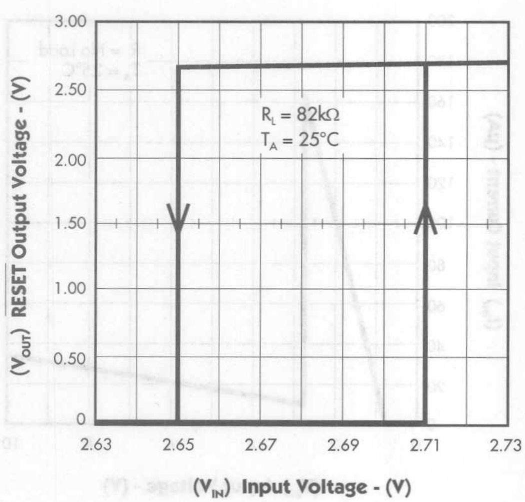


FIGURE 4. — $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. INPUT VOLTAGE



MC33164-3/MC34164-3

3V Undervoltage Sensing Circuit

Production Data Sheet

CHARACTERISTIC CURVES

FIGURE 5. — THRESHOLD VOLTAGE vs. TEMPERATURE

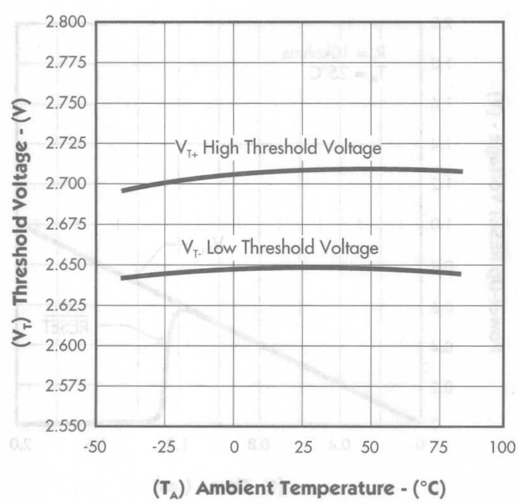


FIGURE 6. — THRESHOLD HYSTERESIS vs. TEMPERATURE

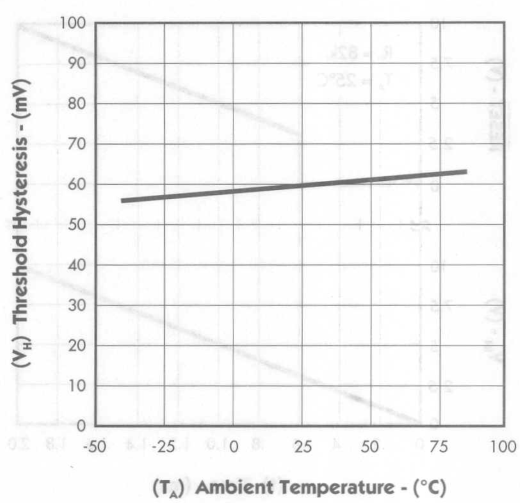


FIGURE 7. — SUPPLY CURRENT vs. INPUT VOLTAGE

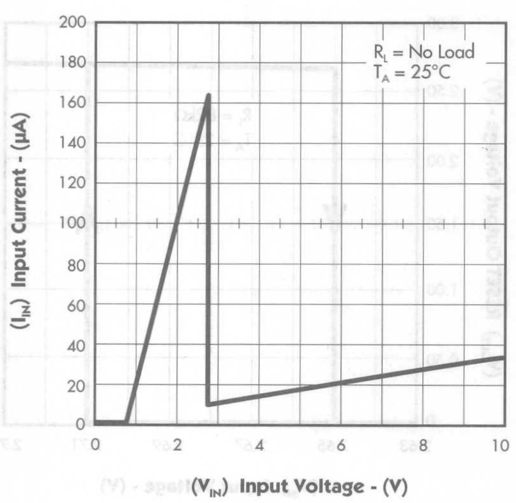
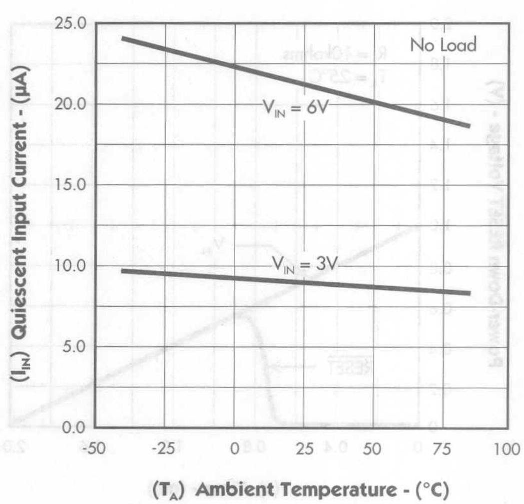


FIGURE 8. — SUPPLY CURRENT vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 9. — LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE

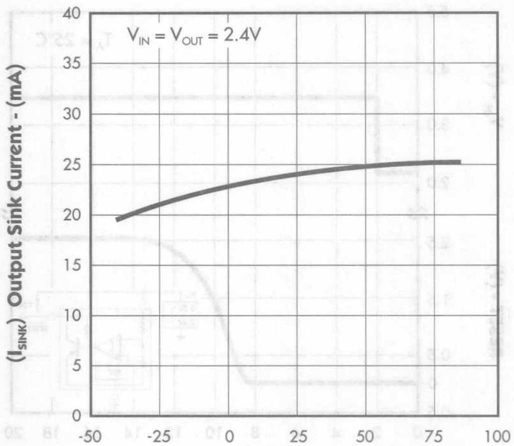


FIGURE 10. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

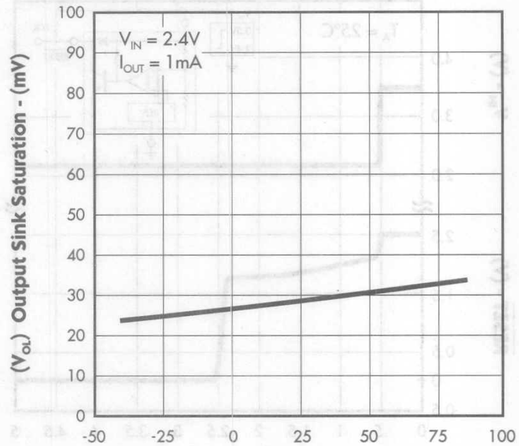


FIGURE 11. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

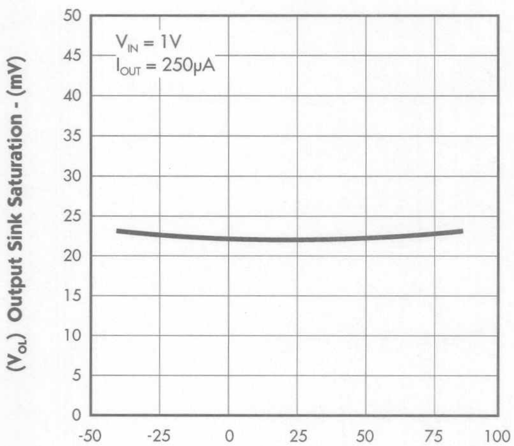
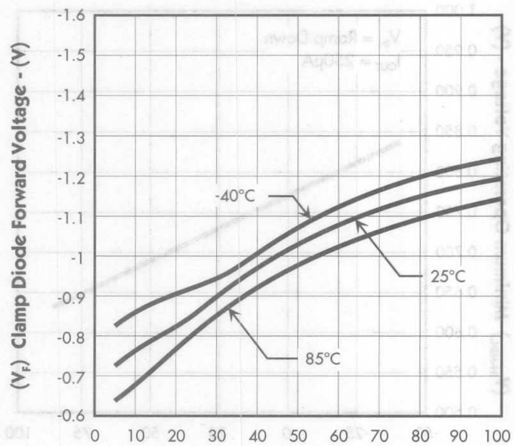


FIGURE 12. — CLAMP DIODE FORWARD VOLTAGE vs. FORWARD CURRENT



CHARACTERISTIC CURVES

FIGURE 13. — PROPAGATION DELAY — HIGH to LOW

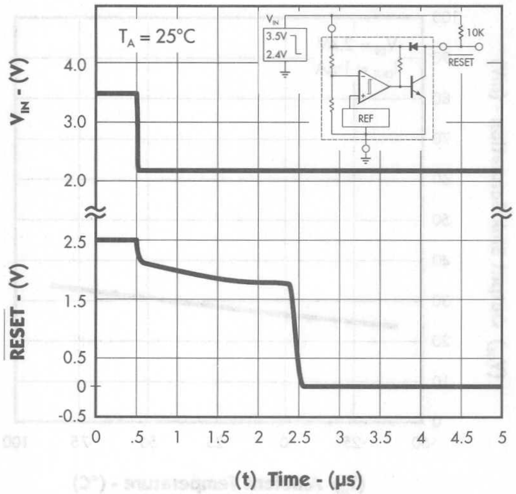


FIGURE 14. — PROPAGATION DELAY — LOW to HIGH

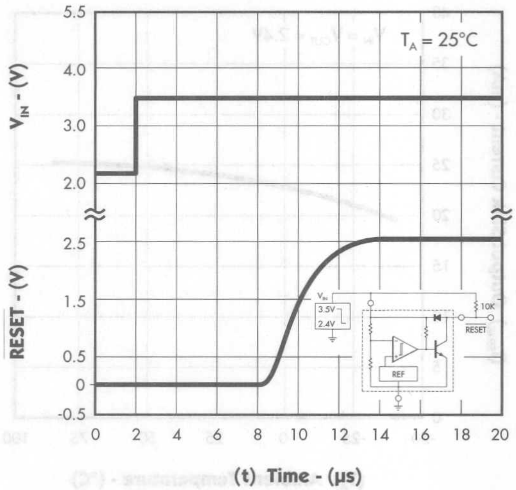
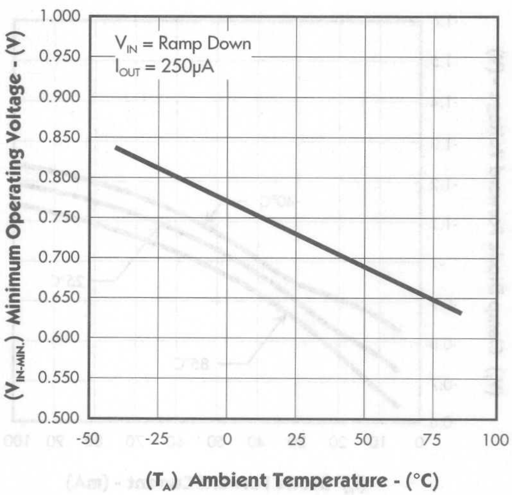


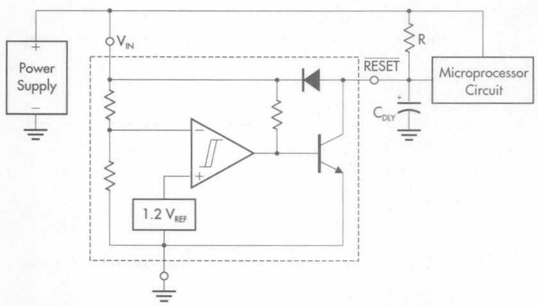
FIGURE 15. — MINIMUM OPERATING VOLTAGE OVER TEMPERATURE



LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

FIGURE 16. — LOW VOLTAGE MICROPROCESSOR RESET



A time delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC_{DLY} time constant be greater than 5.0µs. $V_{TH(MPU)}$ is the microprocessor reset input threshold.

$$t_{DLY} = R\,C_{DLY}\,\ln\left[\frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}}\right]$$

FIGURE 17. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 2.7V

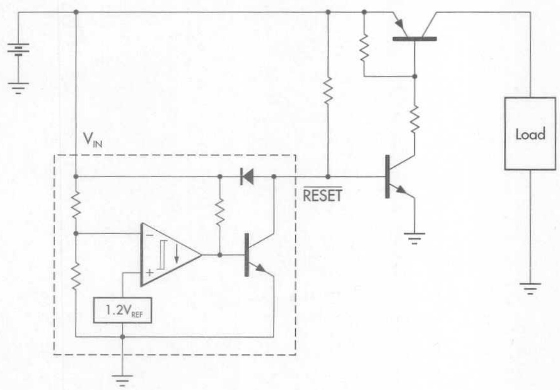
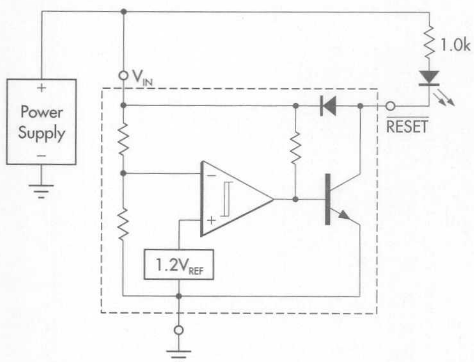
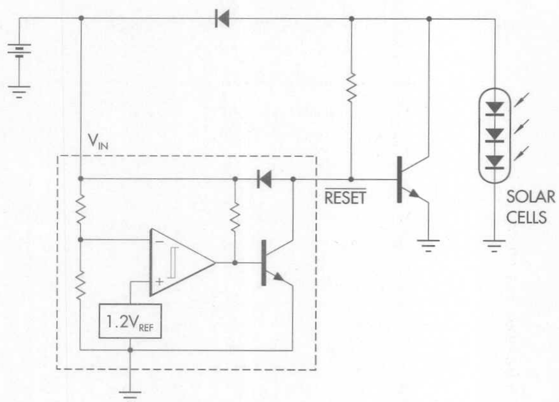


FIGURE 18. — VOLTAGE MONITOR



LED turns on when $V_{IN} < 2.7V$ indicating Power Supply is low.

FIGURE 20. — SOLAR POWERED BATTERY CHARGER



Notes

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MICROELECTRONICS
THE INFINITE POWER OF INNOVATION

SG109/309

5-VOLT FIXED VOLTAGE REGULATORS

PRODUCTION DATA SHEET

DESCRIPTION

The SG109/SG309 is a completely self-contained 5V regulator. Designed to provide local regualtion at currents up to 1A for digital logic cards, this device is available in the hermetic TO-3, TO-66, TO-39 and hermetic and plastic TO-220 packages.

A major feature of the SG109's design is its built-in protective features which make it essentially blowout proof. These consist of both current limiting to control the peak currents and thermal shutdown to protect against excessive power dissipation. With the only added component being a possible need for an input bypass capacitor, this regulator becomes extremely easy to apply. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the zener diode references, such as drift in output voltage and large changes in the line and load regulation.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

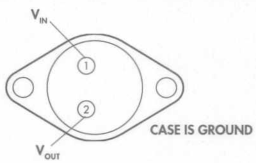
KEY FEATURES

- FULLY COMPATIBLE WITH TTL AND DTL
- OUTPUT CURRENT IN EXCESS OF 1A
- INTERNAL THERMAL OVERLOAD PROTECTION
- NO ADDITIONAL EXTERNAL COMPONENTS
- BANDGAP REFERENCE VOLTAGE
- FOLDBACK CURRENT LIMITING

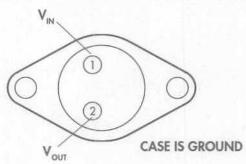
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL - M38510 / 10701BXA - JAN109T
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

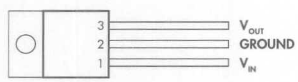
PACKAGE PIN OUTS



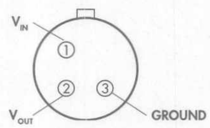
K PACKAGE
(Top View)



R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin
0 to 70	SG309K	SG309R	SG309IG	SG309T
-55 to 125	SG109K	SG109R	SG109IG	SG109T
MIL-STD-883	SG109K/883B	SG109R/883B	SG109IG/883B	SG109T/883B
JAN SPEC.	—	—	—	JAN109T

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Notes

LINFINITY MICROELECTRONICS

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THE INFINITE POWER OF INNOVATION

SG117/117A Family

1.5 Amp Three Terminal Adjustable Voltage Regulator

PRODUCTION DATA SHEET

DESCRIPTION

The SG117A Series are 3-terminal positive adjustable voltage regulators which offer improved performance over the original 117 design. A major feature of the SG117A is reference voltage tolerance guaranteed within ± 1%, allowing an overall power supply tolerance to be better than 3% using inexpensive 1% resistors. Line and load regulation performance has been improved as well. Additionally, the SG117A reference voltage is guaranteed not to exceed 2% when operating over the full load, line and power dissipation conditions. The SG117A adjustable regulators offer an improved solution for all positive voltage regulator requirements with load currents up to 1.5A.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

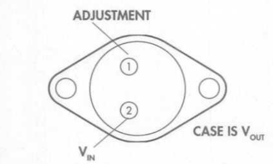
KEY FEATURES

- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.3% LOAD REGULATION
- MINIMUM 1.5A OUTPUT CURRENT

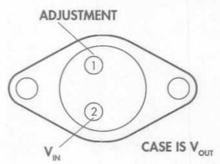
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510 / 11704BYA - JAN117K
- MIL-M38510 / 11703BXA - JAN117T
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

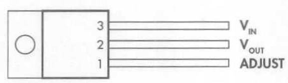
PACKAGE PIN OUTS



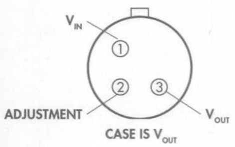
K PACKAGE
(Top View)



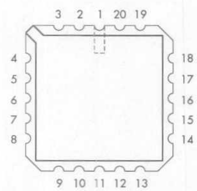
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



1. V_{OUT} SENSE	11. N.C.
2. N.C.	12. N.C.
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. V_{IN}	15. N.C.
6. N.C.	16. N.C.
7. N.C.	17. N.C.
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. ADJUST	20. V_{OUT}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 70	SG317AK*	SG317AR*	—	SG317AT*	—
-25 to 85	SG217AK*	SG217AR*	—	SG217AT*	—
-55 to 125	SG117AK*	SG117AR*	SG117AIG*	SG117AT*	SG117AL*
MIL-STD-883	SG117AK/883B*	SG117AR/883B*	SG117AIG/883B*	SG117AT/883B*	SG117AL/883B*
DESC	SG117AK/DESC*	SG117AR/DESC*	SG117AIG/DESC*	SG117AT/DESC*	SG117AL/DESC*
JAN SPEC.	JAN117K	—	—	JAN117T	—

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.

FOR FURTHER INFORMATION CALL (714) 898-8121
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Notes

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SGR117A

RADHARD 1.5A 3-TERMINAL ADJUSTABLE VOLTAGE REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The RAD HARD SGR117A 3-terminal positive adjustable regulators have been designed to meet the most stringent space and strategic level radiation requirements while meeting the industry standard LM117A and LM117 electrical specifications.

In addition to the features of the standard SGR117A, these devices are capable of meeting the attached data sheet electricals after the following radiation events:

TOTAL DOSE: EXCEEDS 1 MEG RAD

NEUTRON FLUENCE: 5×10^{12} N/cm²

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

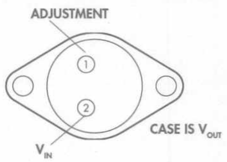
KEY FEATURES

- FULL ELECTRICAL PERFORMANCE AFTER RADIATION EXPOSURE
  - 1 MEG Rad Total Dose
  - 5×10^{12} N/cm²
- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.3% LOAD REGULATION
- MINIMUM 1.5A OUTPUT CURRENT

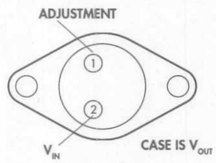
HIGH RELIABILITY FEATURES

- RADIATION DATA AVAILABLE
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

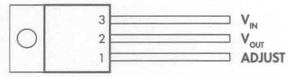
PACKAGE PIN OUTS



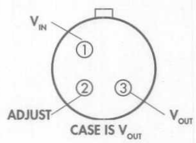
K PACKAGE
(Top View)



R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Hermetic)	T TO-39 Metal Can 3-pin
-55 to 125	SGR117AK*	SGR117AR*	SGR117AIG*	SGR117AT*
MIL-STD-883	SGR117AK/883B*	SGR117AR/883B*	SGR117AIG/883B*	SGR117AT/883B*

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

SG120

NEGATIVE FIXED VOLTAGE REGULATOR

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PRODUCTION DATA SHEET

DESCRIPTION

The SG120 series of negative regulators offer self-contained, fixed-voltage capability with up to 1.5A of load current. With a variety of output voltages and four package options this regulator series is an optimum complement to the SG7800A/7800/120 line of three terminal regulators.

All protective features of thermal shutdown, current limiting, and safe-area control have been designed into these units and since these regulators require only a single output capacitor or a capacitor and 5mA minimum load for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used, especially for the SG120 series. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the zener diode references, such as drift in output voltage and large changes in the line and load regulation

These devices are available in TO-257 (hermetically sealed TO-220), both isolated and non-isolated), TO-3, TO-39 and TO-66 power packages.

KEY FEATURES

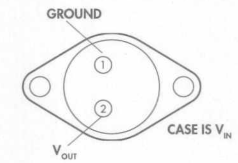
- OUTPUT CURRENT TO 1.5A
- EXCELLENT LINE AND LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: -5V, -5.2V, -8V, -12V, -15V, -18V, -20V
- CONTACT FACTORY FOR OTHER VOLTAGE OPTIONS

HIGH RELIABILITY FEATURES

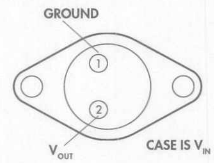
- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

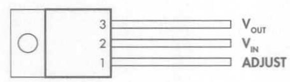
PACKAGE PIN OUTS



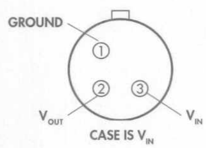
K PACKAGE
(Top View)



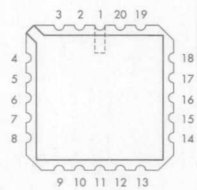
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



1. N.C.	11. N.C.
2. V_{IN}	12. N.C.
3. N.C.	13. N.C.
4. V_{OUT}	14. N.C.
5. V_{OUT}	15. GND
6. N.C.	16. N.C.
7. V_{OUT} SENSE	17. GND
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. N.C.	20. V_{IN}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
-55 to 125	SG120-xxK	SG120-xxR	SG120-xxIG	SG120-xxT	SG120-xxL
MIL-STD-883	SG120-xxK/883B	SG120-xxR/883B	SG120-xxIG/883B	SG120-xxT/883B	SG120-xxL/883B

FOR FURTHER INFORMATION CALL (714) 898-8121

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Notes

LINFINITY
MICROELECTRONICS
THE INFINITE POWER OF INNOVATION

SG137/137A Family

1.5 Amp Negative Adjustable Regulator

Production Data Sheet

DESCRIPTION

The SG137A family of negative adjustable regulators will deliver up to 1.5A output current over an output voltage range of -1.2V to -37V. Linfinity has made significant improvements in these regulators compared to previous devices, such as better line and load regulation, and a maximum output voltage error of 1%. The SG137 family uses the same chip design and guarantees maximum output voltage error of ±2%.

Every effort has been made to make these devices easy to use and difficult to damage. Internal current and power limiting coupled with true thermal limiting prevents device damage due to overloads or shorts even if the regulator is not fastened to a heat sink.

The SG137A/137 family of products are ideal complements to the SG117A/117 adjustable positive regulators.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

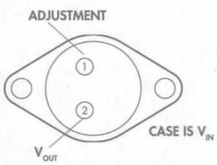
KEY FEATURES

- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.5% LOAD REGULATION
- 0.02%/W THERMAL REGULATION

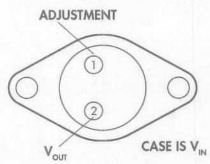
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- SCHEDULED FOR MIL-M38510 QPL TESTING
- MIL-M38510 / 11804BYA - JAN137K
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

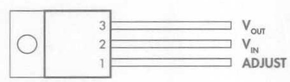
PACKAGE PIN OUTS



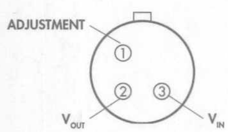
K PACKAGE
(Top View)



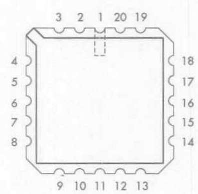
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



L PACKAGE
(Top View)

1. V_{OUT}
2. V_{OUT}
3. N.C.
4. N.C.
5. N.C.
6. N.C.
7. N.C.
8. N.C.
9. N.C.
10. N.C.
11. V_{IN}
12. N.C.
13. N.C.
14. N.C.
15. N.C.
16. ADJUST
17. N.C.
18. N.C.
19. N.C.
20. N.C.

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 70	SG337AK*	SG337AR*	—	SG337AT*	—
-25 to 85	SG237AK*	SG237AR*	—	SG237AT*	—
-55 to 125	SG137AK*	SG137AR*	SG137AIG*	SG137AT*	SG137AL*
MIL-STD-883	SG137AK/883B*	SG137AR/883B*	SG137AIG/883B*	SG137AT/883B*	SG137AL/883B*
DESC	SG137AK/DESC*	SG137AR/DESC*	SG137AIG/DESC*	SG137AT/DESC*	SG137AL/DESC*
JAN SPEC.	JAN137K	—	—	—	—

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.

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LINFINITY MICROELECTRONICS

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SG140A/SG140

POSITIVE FIXED VOLTAGE REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG140A/140 series of positive regulators offer self contained, fixed-voltage capability with up to 1.5A of load current and input voltage up to 50V (SG140A series only).

These units feature a unique on-chip trimming system to set the output voltages to within ±1.5% of nominal on the SG140A series and ±2.0% on the SG140 series. The SG140A versions also offer much improved line and load regulation characteristics. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the Zener Diode references, such as drift in output voltage and large changes in the line and load regulation.

All protective features of thermal shutdown, current limiting, and safe-area control have been designed into these units and since these regulators require only a small output capacitor for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

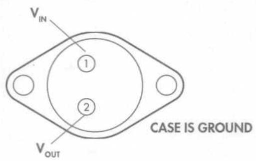
KEY FEATURES

- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG140A
- INPUT VOLTAGE RANGE TO 50V MAX. ON SG140A
- 2 VOLT INPUT/OUTPUT DIFFERENTIAL
- BANDGAP REFERENCE VOLTAGE
- EXCELLENT LINE AND LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: 5V, 6V, 8V, 12V, 15V, 18V, 24V

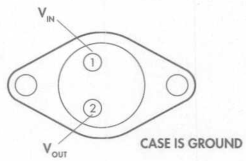
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

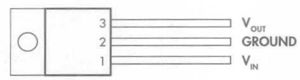
PACKAGE PIN OUTS



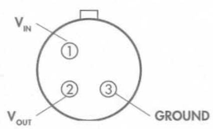
K PACKAGE
(Top View)



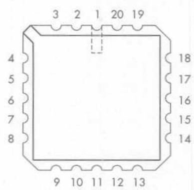
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



1. N.C.
2. V_{IN}
3. N.C.
4. N.C.
5. N.C.
6. N.C.
7. GROUND
8. N.C.
9. N.C.
10. V_{OUT}
11. N.C.
12. V_{OUT}
13. N.C.
14. N.C.
15. V_{OUT} SENSE
16. N.C.
17. V_{IN}
18. N.C.
19. N.C.
20. N.C.

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
-55 to 125	SG140-xxK	SG140-xxR	SG140-xxAIG*	SG140-xxT	SG140-xxL
MIL-STD-883	SG140-xxK/883B	SG140-xxR/883B	SG140-xxAIG/883B*	SG140-xxT/883B	SG140-xxL/883B

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.
Note: "xx" to be replaced by output voltage of specific fixed regulator.

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1524/2524/3524

REGULATING PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic integrated circuit contains all the control circuitry for a regulating power supply inverter or switching regulator. Included in a 16-pin dual-in-line package is the voltage reference, error amplifier, oscillator, pulse width modulator, pulse steering flip-flop, dual alternating output switches and current limiting and shut-down circuitry. This device can be used for switching regulators of either polarity, transformer coupled DC to DC converters, transformerless voltage doublers and polarity converters, as well as other power applications. The SG1524 is specified for operation over the full military ambient temperature range of -55°C to +125°C, the SG2524 for -25°C to +85°C, and the SG3524 is designed for commercial applications of 0°C to +70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

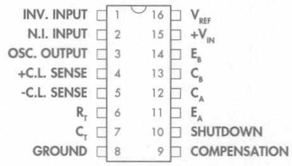
KEY FEATURES

- 8V TO 40V OPERATION
- 5V REFERENCE
- REFERENCE LINE & LOAD REG. OF 0.4%
- REFERENCE TEMP. COEFFICIENT < ±1%
- 100Hz TO 300KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 50mA OUTPUT TRANSISTORS
- CURRENT LIMIT CIRCUITRY
- COMPLETE PWM POWER CONTROL CIRCUITRY
- SINGLE ENDED OR PUSH-PULL OUTPUTS
- TOTAL SUPPLY CURRENT LESS THAN 10mA

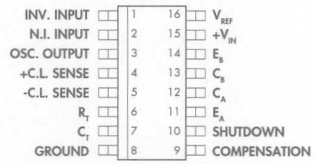
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M-38510/12601BEA - JAN1524J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

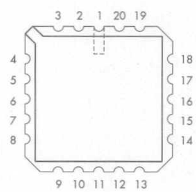
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



D PACKAGE
(Top View)



1. N.C.
2. V_{REF}
3. INV. INPUT
4. N.I. INPUT
5. OSC. OUTPUT
6. +C.L. SENSE
7. -C.L. SENSE
8. R_T
9. C_T
10. GROUND
11. COMPENSATION
12. SHUTDOWN
13. N.C.
14. E_A
15. C_A
16. N.C.
17. C_B
18. E_B
19. N.C.
20. $+V_{IN}$

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	D Plastic SOIC 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3524N	SG3524J	SG3524D	—
-25 to 85	SG2524N	SG2524J	SG2524D	—
-55 to 125	—	SG1524J	—	SG1524L
MIL-STD-883	—	SG1524J/883B	—	SG1524L/883B
DESC	—	SG1524J/DESC	—	—
JAN	—	JAN1524J	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3524DT)

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SG1524B/2524B/3524B

REGULATING PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1524B is a pulse width modulator for switching power supplies which features improved performance over industry standards like the SG1524. A direct pin-for-pin replacement for the earlier device, it combines advanced processing techniques and circuit design to provide improved reference accuracy, and extended common mode range at the error amplifier and current limit inputs. A DC-coupled flip-flop eliminates triggering and glitch problems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response, while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the Shutdown pin is used for pulse-by-pulse current limiting.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 3-1) AND 1990/91 SILICON GENERAL DATABOOK

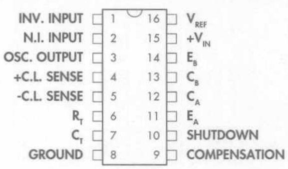
KEY FEATURES

- 7V TO 40V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 100Hz TO 400KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 100mA OUTPUT TRANSISTORS
- WIDE CURRENT LIMIT COMMON MODE RANGE
- DC-COUPLED TOGGLE FLIP-FLOP
- PWM DATA LATCH
- UNDERVOLTAGE LOCKOUT
- FULL DOUBLE-PULSE SUPPRESION LOGIC
- 60V OUTPUT COLLECTORS

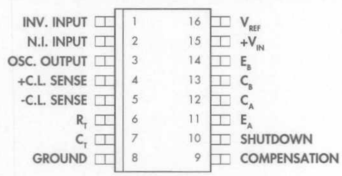
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

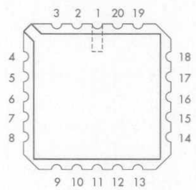
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.
2. INV. INPUT
3. N.I. INPUT
4. OSC. OUTPUT
5. +C.L. SENSE
6. N.C.
7. -C.L. SENSE
8. R_T
9. C_T
10. GROUND
11. N.C.
12. COMPENSATION
13. SHUTDOWN
14. E_A
15. C_A
16. N.C.
17. C_B
18. E_B
19. $+V_{IN}$
20. V_{REF}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3524BN	SG3524BJ	SG3524BDW	—
-25 to 85	SG2524BN	SG2524JBJ	SG2524BDW	—
-55 to 125	—	SG1524BJ	—	SG1524BL
MIL-STD-883	—	SG1524BJ/883B	—	SG1524BL/883B
DESC	—	SG1524BJ/DESC	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3524BDWT)

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1525A/SG1527A Family

REGULATING PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1525A/1527A series of pulse width modulator integrated circuits are designed to offer improved performance and lower external parts count when used to implement all types of switching power supplies. The on-chip +5.1 volt reference is trimmed to ±1% initial accuracy and the input common-mode range of the error amplifier includes the reference voltage, eliminating external potentiometers and divider resistors. A Sync input to the oscillator allows multiple units to be slaved together, or a single unit to be synchronized to an external system clock. A single resistor between the C_T pin and the Discharge pin provides a wide range of deadtime adjustment. These devices also feature built-in soft-start circuitry with only a timing capacitor required externally. A Shutdown pin controls both the soft-start circuitry and the output stages, providing instantaneous turn-off with soft-start recycle for slow turn-on. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for input voltages less than that required for normal operation. Another unique feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The SG1525A output stage features NOR logic, giving a LOW output for an OFF state. The SG1527A utilizes OR logic which results in a HIGH output level when OFF.

KEY FEATURES

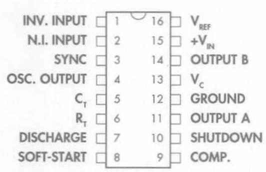
- 8V TO 35V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 100Hz TO 500KHz OSCILLATOR RANGE
- SEPARATE OSCILLATOR SYNC TERMINAL
- ADJUSTABLE DEADTIME CONTROL
- INTERNAL SOFT-START
- INPUT UNDERVOLTAGE LOCKOUT
- LATCHING PWM TO PREVENT MULTIPLE PULSES
- DUAL SOURCE / SINK OUTPUT DRIVERS

HIGH RELIABILITY FEATURES

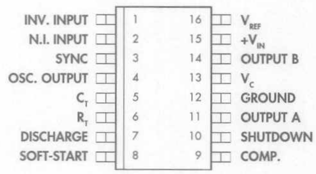
- AVAILABLE TO MIL-STD-883B
- MIL-M-38510 / 12602BEA - JAN1525AJ
- MIL-M-38510 / 12604BEA - JAN1527AJ
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

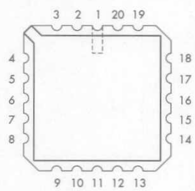
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.
2. INV. INPUT
3. N.I. INPUT
4. SYNC
5. OSC. OUTPUT
6. N.C.
7. C_T
8. R_T
9. DISCHARGE
10. SOFT-START
11. N.C.
12. COMP.
13. SHUTDOWN
14. OUTPUT A
15. GROUND
16. N.C.
17. V_C
18. OUTPUT B
19. $+V_{IN}$
20. V_{REF}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3525AN	SG3525AJ	SG3525DW	—
	SG3527AN	SG3525AJ	SG3525DW	—
-25 to 85	SG2525AN	SG2525AJ	SG2525ADW	—
	SG2527AN	SG2527AJ	SG2527ADW	—
-55 to 125	—	SG1525AJ	—	SG1525AL
	—	SG1527AJ	—	SG1527AL
MIL-STD-883	—	SG1525AJ/883B	—	SG1525AL/883B
	—	SG1527AJ/883B	—	SG1527AL/883B
DESC	—	SG1525AJ/DESC	—	—
	—	SG1527AJ/DESC	—	—
JAN	—	JAN1525A	—	—
	—	JAN1527A	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3525DWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

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Notes

LINFINITY MICROELECTRONICS

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SG1526/SG2526/SG3526

REGULATING PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1526 is a high performance monolithic pulse width modulator circuit designed for fixed-frequency switching regulators and other power control applications. Included in an 18-pin dual-in-line package are a temperature compensated voltage reference, sawtooth oscillator, error amplifier, pulse width modulator, pulse metering and steering logic, and two low impedance power drivers. Also included are protective features such as soft-start and undervoltage lockout, digital current limiting, double pulse inhibit, a data latch for single pulse metering, adjustable deadtime, and provision for symmetry correction inputs. For ease of interface, all digital control ports are TTL and B-series CMOS compatible. Active LOW logic design allows wired-OR connections for maximum flexibility. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformerless and transformer coupled.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

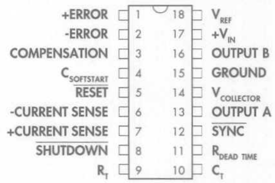
KEY FEATURES

- 8V TO 35V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 1Hz TO 350KHz OSCILLATOR RANGE
- DUAL 100mA SOURCE/SINK OUTPUTS
- DIGITAL CURRENT LIMITING
- DOUBLE PULSE SUPPRESSION
- PROGRAMMABLE DEADTIME
- UNDERVOLTAGE LOCKOUT
- SINGLE PULSE METERING
- PROGRAMMABLE SOFT-START
- WIDE CURRENT LIMIT COMMON MODE RANGE
- TTL/CMOS COMPATIBLE LOGIC PORTS
- SYMMETRY CORRECTION CAPABILITY
- GUARANTEED 6 UNIT SYNCHRONIZATION

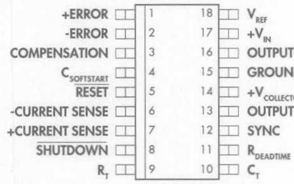
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

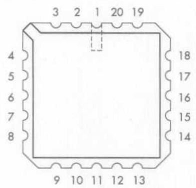
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.
2. +ERROR
3. -ERROR
4. COMP
5. $C_{SOFTSTART}$
6. RESET
7. -C.S.
8. +C.S.
9. SHUTDOWN
10. R_T
11. C_T
12. $R_{DEADTIME}$
13. SYNC
14. OUTPUT A
15. $+V_{COLLECTOR}$
16. N.C.
17. GROUND
18. OUTPUT B
19. $+V_{IN}$
20. V_{REF}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3526N	SG3526J	SG3526DW	—
-25 to 85	SG2526N	SG2526J	SG2526DW	—
-55 to 125	—	SG1526J	—	SG1526L
MIL-STD-883	—	SG1526J/883B	—	SG1526L/883B

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3526DWT)

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1526B/SG2526B/SG3526B

REGULATING PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1526B is a high-performance pulse width modulator for switching power supplies which offers improved functional and electrical characteristics over the industry-standard SG1526. A direct pin-for-pin replacement for the earlier device with all its features, it incorporates the following enhancements: a bandgap reference circuit for improved regulation and drift characteristics, improved undervoltage lockout, lower temperature coefficients on oscillator frequency and current-sense threshold, tighter tolerance on softstart time, much faster SHUTDOWN response, improved double-pulse suppression logic for higher speed operation, and an improved output driver design with low shoot-through current, and faster rise and fall times. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformer-less and transformer-coupled.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

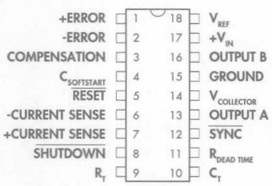
KEY FEATURES

- 8V TO 35V OPERATION
- 5V LOW DRIFT 1% BANDGAP REFERENCE
- 1Hz TO 500KHz OSCILLATOR RANGE
- DUAL 100mA SOURCE/SINK
- DIGITAL CURRENT LIMITING
- DOUBLE PULSE SUPPRESSION
- PROGRAMMABLE DEADTIME
- IMPROVED UNDERVOLTAGE LOCKOUT
- SINGLE PULSE METERING
- PROGRAMMABLE SOFT-START
- WIDE CURRENT LIMIT COMMON MODE RANGE
- TTL/CMOS COMPATIBLE LOGIC PORTS
- SYMMETRY CORRECTION CAPABILITY
- GUARANTEED 6 UNIT SYNCHRONIZATION
- SHOOT THRU CURRENTS LESS THAN 100mA
- IMPROVED SHUTDOWN DELAY
- IMPROVED RISE AND FALL TIME

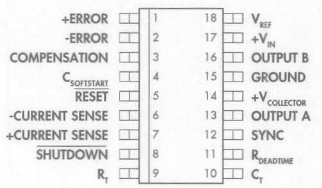
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/12603BVA - JAN1526BJ
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

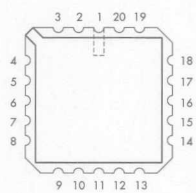
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.
2. +ERROR
3. -ERROR
4. COMP
5. $C_{SOFTSTART}$
6. RESET
7. -C.S.
8. +C.S.
9. SHUTDOWN
10. R_T
11. C_T
12. $R_{DEADTIME}$
13. SYNC
14. OUTPUT A
15. $+V_{COLLECTOR}$
16. N.C.
17. GROUND
18. OUTPUT B
19. $+V_{IN}$
20. V_{REF}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3526BN	SG3526BJ	SG3526BDW	—
-25 to 85	SG2526BN	SG2526BJ	SG2526BDW	—
-55 to 125	—	SG1526BJ	—	SG1526BL
MIL-STD-883	—	SG1526BJ/883B	—	SG1526BL/883B
DESC	—	SG1526BJ/DESC	—	—
JAN	—	JAN1526BJ	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3526BDWT)

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THE INFINITE POWER OF INNOVATION

SG1529/2529/3529

REGULATING PULSE WIDTH MODULATOR

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG1529 series of pulse width modulator integrated circuits are designed to provide all the operational features of the SG1524B series with the added advantage of an uncommitted input to the PWM comparator. This allows the device to be used in Feed-Forward regulation schemes to achieve better line regulation as well as improved dynamic response. A 5V bandgap reference trimmed to ±1% tolerance, an error amplifier, and a current limit comparator with a high common mode range are included in the IC.

A DC coupled flip-flop eliminates triggering and glitch problems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the Shutdown pin is used for pulse-by-pulse current limiting.

KEY FEATURES

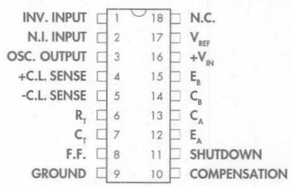
- FEED FORWARD CAPABILITY
- 7V TO 40V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 100Hz TO 400KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 100mA OUTPUT TRANSISTORS
- WIDE CURRENT LIMIT COMMON MODE RANGE
- DC-COUPLED TOGGLE FLIP-FLOP
- PWM DATA LATCH
- UNDERVOLTAGE LOCKOUT
- FULL DOUBLE-PULSE SUPPRESION LOGIC
- 60V OUTPUT COLLECTORS

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin
0 to 70	SG3529N	SG3529J
-25 to 85	SG2529N	SG2529J
-55 to 125	—	SG1529J
MIL-STD-883	—	SG1529J/883B

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1532/SG2532/SG3532

PRECISION GENERAL-PURPOSE REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic integrated circuit is a versatile, general-purpose voltage regulator designed as a substantially improved replacement for the popular SG723 device. The SG1532 series regulators retain all the versatility of the SG723 but have the added benefits of operation with input voltages as low as 4.5 volts and as high as 50 volts; a low noise, low voltage reference; temperature compensated, low threshold current limiting; and protective circuits which include thermal shutdown and independent current limiting; and protective circuits which include thermal shutdown and independent current limiting of both the reference and output voltages. A seperate remote shutdown terminal is included. In the dual-in-line package an open collector output is available for low input-output differential applications.

These devices are available in both hermetic 14-pin and 10-pin TO-96 packages. In the T-package, these units are interchangeable with the LAS-1000 and LAX-1100 regulators.

KEY FEATURES

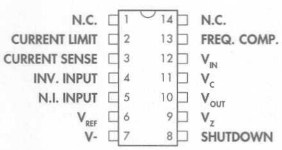
- INPUT VOLTAGE RANGE OF 4.5V TO 50V
- 2.5V LOW NOISE REFERENCE
- INDEPENDENT SHUTDOWN TERMINAL
- IMPROVED LINE AND LOAD REGULATION
- 80mV CURRENT LIMIT SENSE VOLTAGE
- FULLY PROTECTED INCLUDING THERMAL SHUTDOWN
- USEFUL OUTPUT CURRENT TO 150mA

HIGH RELIABILITY FEATURES

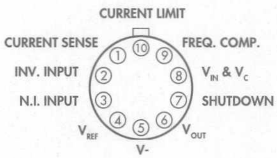
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

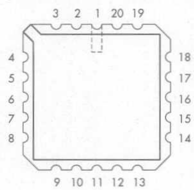
PACKAGE PIN OUTS



J PACKAGE
(Top View)



T PACKAGE
(Top View)



1. N.C.
2. CURRENT LIMIT
3. CURRENT SENSE
4. N.C.
5. INV. INPUT
6. N.C.
7. N.I. INPUT
8. V_{REF}
9. N.C.
10. V-
11. N.C.
12. SHUTDOWN
13. V_Z
14. N.C.
15. V_{OUT}
16. N.C.
17. V_C
18. V_{IN}
19. N.C.
20. FREQ. COMP.

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	T T0-100 Metal Can 10-pin	L Ceramic LCC 20-pin
0 to 70	SG2532J	SG2532T	—
	SG3532J	SG3532T	—
-55 to 125	SG1532J	SG1532T	SG1532L
MIL-STD-883	SG1532J/883B	SG1532T/883B	SG1532L/883B
DESC	SG1532J/DESC	SG1532T/DESC	—

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THE INFINITE POWER OF INNOVATION

SG1540/SG2540/SG3540

OFF-LINE START-UP CONTROLLER

NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

DESCRIPTION

The SG1540 is an integrated circuit designed to efficiently provide start-up power from a high-voltage DC bus to a PWM control circuit in a switching power supply. When used on the primary side, it reduces start-up current to less than 1mA and allows any standard PWM control circuit to be used as a primary-side controller. When used to power a controller on the secondary side, it efficiently eliminates the need for a heavy 50/60Hz line transformer with its associated low frequency magnetic fields.

The circuit consists of three sections: a micropower bandgap comparator/power switch referenced to 2.5 volts which isolates the start-up capacitor from its load; a high frequency square-wave oscillator with 200mA totem-pole output for driving an isolation transformer; and a second bandgap comparator with latching crowbar to protect against overvoltage faults while starting or running.

The SG1540 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2540 is characterized for the industrial range of -25°C to 85°C, and the SG3540 is designed for the commercial range of 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

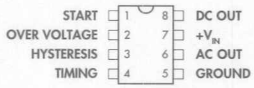
KEY FEATURES

- USEABLE WITH PRIMARY AND SECONDARY SIDE PWM CONTROLLERS
- MICROPOWER COMPARATOR / SWITCH
  - INTERNAL 2.5V BANDGAP REFERENCE
  - 50mA POWER SWITCH
- SQUAREWAVE OSCILLATOR
  - 500Hz TO 200KHz OPERATION
  - 200mA TOTEM POLE OUTPUTS
- ELIMINATES BULKY, EXPENSIVE 50/60 Hz TRANSFORMER
- INPUT CURRENT 35nA MAXIMUM OVER TEMPERATURE
- MINIMIZES HIGH VOLTAGE BLEEDER CURRENT
- PROGRAMMABLE START-UP VOLTAGE AND HYSTERESIS
- INTERNAL AND PROGRAMMABLE OVERVOLTAGE CROWBAR LATCH

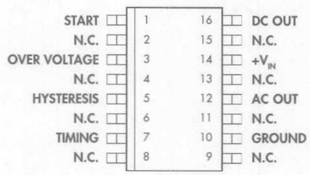
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)



DW PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	DW Plastic SOWB 16-pin
0 to 70	SG3540M	SG3540Y	SG3540DW
-25 to 85	SG2540M	SG2540Y	SG2540DW
-55 to 125	—	SG1540Y	—
MIL-STD-883	—	SG1540Y/883B	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3540DWT)

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Notes

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THE INFINITE POWER OF INNOVATION

LIN Doc #: 1543

SG1543/SG2543/SG3543

POWER SUPPLY OUTPUT SUPERVISORY CIRCUIT

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic integrated circuit contains all the functions necessary to monitor and control the output of a sophisticated power supply system. Over-voltage (O.V.) sensing with provision to trigger an external SCR "crowbar" shutdown; an under-voltage (U.V.) circuit which can be used to monitor either the output or to sample the input line voltage; and a third op amp/comparator usable for current sensing (C.L.) are all included in this IC, together with an independent, accurate reference generator.

Both over and under-voltage sensing circuits can be externally programmed for minimum time duration of fault before triggering. All functions contain open collector outputs which can be used independently or wire-ORed together; and although the SCR trigger is directly connected only to the over-voltage sensing circuit, it may be optionally activated by any of the other outputs, or from an external signal. The O.V. circuit also includes an optional latch and external reset capability.

The current sense circuit may be used with external compensation as a linear amplifier or as a high gain comparator. Although nominally set for zero input offset, a fixed threshold may be added with an external resistor. Instead of current limiting, this circuit may also be used as an additional voltage monitor.

The reference generator circuit is internally trimmed to eliminate the need for external potentiometers and the entire circuit may be powered directly from either the output being monitored or from a seperate bias voltage.

KEY FEATURES

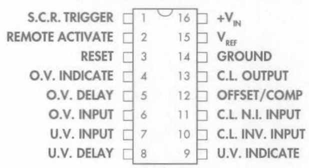
- OVER-VOLTAGE, UNDER-VOLTAGE, AND CURRENT SENSING CIRCUITS ALL INCLUDED
- REFERENCE VOLTAGE TRIMMED TO 1% ACCURACY
- SCR "CROWBAR" DRIVE OF 300mA
- PROGRAMMABLE TIME DELAYS
- OPEN-COLLECTOR OUTPUTS AND REMOTE ACTIVATION CAPABILITY
- TOTAL STANDBY CURRENT LESS THAN 10mA

HIGH RELIABILITY FEATURES

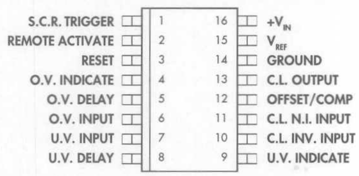
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

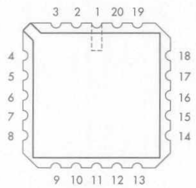
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.
2. SCR TRIGGER
3. REMOTE ACTIVATE
4. RESET
5. O.V. INDICATE
6. N.C.
7. O.V. DELAY
8. O.V. INPUT
9. U.V. INPUT
10. U.V. DELAY
11. N.C.
12. U.V. INDICATE
13. C.L. INV. INPUT
14. C.L. N.I. INPUT
15. OFFSET/COMP
16. N.C.
17. C.L. OUTPUT
18. GROUND
19. V_{REF}
20. +V_{IN}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3543N	SG3543J	SG3543DW	—
-25 to 85	SG2543N	SG2543J	SG2543DW	—
-55 to 125	—	SG1543J	—	SG1543L
MIL-STD-883	—	SG1543J/883B	—	SG1543L/883B
DESC	—	SG1543J/DESC	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3543DWT)

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SG1544/SG2544/SG3544

Low-Voltage Supervisory Circuit

Production Data Sheet

DESCRIPTION

This device was designed to provide all the operational features of the SG1543/2543/3543 devices but with the added advantage of uncommitted inputs to the voltage sensing comparators. This allows monitoring of voltage levels less than 2.5 volts by dividing down the internal reference supply.

In all other respects, the SG1544 series is identical to the SG1543 series. These monolithic devices contain all the functions necessary to monitor and control the output of a sophisticated power supply system. Over-voltage sensing with provision to trigger an external SCR "crowbar" shutdown; an under-voltage circuit which can be used to monitor either the output or sample the input line voltage; and a third op amp/comparator usable for current sensing are all included in this IC, together with an independent, accurate reference generator.

The voltage-sensing input comparators are identical and can be used with threshold levels from zero volts to (V_{IN}-3V). Each has approximately 25mV of hysteresis which is offset so the switching differential threshold is zero on the non-inverting input for rising levels and zero on the inverting input for falling signals. All other operating characteristics are as described in the SG1543 data sheet and application note.

KEY FEATURES

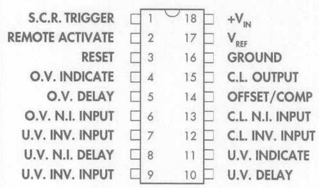
- UNCOMMITTED COMPARATOR INPUTS FOR WIDE INPUT FLEXIBILITY
- COMMON-MODE RANGE FROM ZERO TO NEAR SUPPLY VOLTAGE
- REFERENCE VOLTAGE TRIMMED TO 1% ACCURACY
- OVER-VOLTAGE, UNDER-VOLTAGE, AND CURRENT SENSING CIRCUITS ALL INCLUDED
- SCR "CROWBAR" DRIVE OF 300mA
- PROGRAMMABLE TIME DELAYS
- OPEN-COLLECTOR OUTPUTS AND REMOTE ACTIVATION CAPABILITY
- TOTAL STANDBY CURRENT LESS THAN 10mA

HIGH RELIABILITY FEATURES

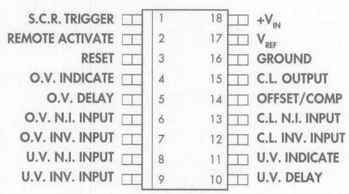
- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin
0 to 70	SG3544N	SG3544J	SG3544DW
-25 to 85	SG2544N	SG2544J	SG2544DW
-55 to 125	—	SG1544J	—
MIL-STD-883	—	SG1544J/883B	—
DESC	—	SG1544J/DESC	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3544DWT)

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1548/SG2548/SG3548

QUAD POWER FAULT MONITOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1548 is an integrated circuit capable of monitoring up to four positive DC supply voltages simultaneously for overvoltage and undervoltage fault conditions. An on-chip inverting op amp also allows monitoring one negative DC voltage. The fault tolerance window is accurately programmable from ±5% to ±40% using a simple divider network on the 2.5V reference. A single external capacitor sets the fault indication delay, eliminating false outputs due to switching noise, logic transition current spikes, and short-term AC line interruptions.

An additional comparator referenced to 2.5V allows the AC line to be monitored for undervoltage conditions or for generation of a line clock. The comparator can also be used for programmable undervoltage lockout in a switching power supply. Uncommitted collector and emitter outputs permit both inverting and non-inverting operation. External availability of the precision 2.5V reference and open-collector logic outputs permit expansion to monitor additional voltage using available open-collector quad comparators.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

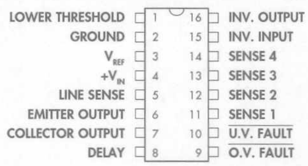
KEY FEATURES

- MONITORS 4 DC VOLTAGES & THE AC LINE
- PRECISION 2.5V ±1% LOW-DRIFT REFERENCE
- FAULT TOLERANCE ADJUSTABLE FROM ±5% TO ±40%
- ±3% TRIP THRESHOLD TOL. OVER TEMP.
- SEPERATE 10mA, 40V OVERVOLTAGE, UNDERVOLTAGE & AC LINE FAULT OUTPUTS
- FAULT DELAY PROGRAMMABLE WITH SINGLE CAPACITOR
- 30mV COMPARATOR HYSTERESIS TO PREVENT OSCILLATIONS
- ON-CHIP INVERTING OP AMP FOR NEGATIVE VOLTAGE
- OPEN-COLLECTOR OUTPUT LOGIC OR EXPANDABILITY
- OPERATION FROM 4.5V TO 40V SUPPLY

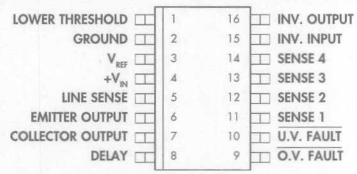
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

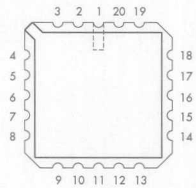
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



1. N.C.	11. N.C.
2. LOWER THRESHOLD	12. O.V. FAULT
3. GROUND	13. U.V. FAULT
4. V_{REF}	14. SENSE 1
5. $+V_{IN}$	15. SENSE 2
6. N.C.	16. N.C.
7. LINE SENSE	17. SENSE 3
8. EMITTER OUTPUT	18. SENSE 4
9. COLLECTOR OUTPUT	19. INV. INPUT
10. DELAY	20. INV. OUTPUT

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3548N	SG3548J	SG3548DW	—
-25 to 85	SG2548N	SG2548J	SG2548DW	—
-55 to 125	—	SG1548J	—	SG1548L
MIL-STD-883	—	SG1548J/883B	—	SG1548L/883B

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3548DWT)

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1549/SG2549/SG3549

CURRENT SENSE LATCH

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic integrated circuit is an analog latch device with digital reset. It was specifically designed to provide pulse-by-pulse current limiting for switch-mode power supply systems, but many other applications are also feasible. Its function is to provide a latching switch action upon sensing an input threshold voltage, with reset accomplished by an external clock signal. This device can be interfaced directly with many kinds of pulse width modulating control IC's, including the SG1524, SG1525A, and SG1527A.

The input threshold for the latch circuit is 100mV, which can be referenced either to ground or to a wide-ranging positive voltage. There are high and low-going output signals available, and both the supply voltage and clock signal can be taken directly from an associated PWM control chip.

With delays in the range of 200 nanoseconds, this latch circuit is ideal for fast reaction sensing to provide overall current limiting, short circuit protection, or transformer saturation control.

KEY FEATURES

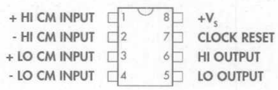
- CURRENT SENSING WITH 100mV THRESHOLD
- COMMON-MODE INPUT AT GROUND OR TO 40V
- COMPLEMENTARY OUTPUTS
- AUTOMATIC RESET FROM PWM CLOCK
- 180ns DELAY
- INTERFACE DIRECT TO SG1524, SG1525A, SG1527A

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin
0 to 70	SG3549Y	SG3529M
-25 to 85	SG2549Y	SG2549M
-55 to 125	SG1549Y	—
MIL-STD-883	SG1549Y/883B	—
DESC	SG1549Y/DESC	—

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1626/SG2626/SG3626

DUAL HIGH-SPEED DRIVER

PRODUCTION DATA SHEET

DESCRIPTION

The SG1626, SG2626, SG3636 is a dual inverting monolithic high speed driver that is pin-for-pin compatible with the DS0026, TSC426 and ICL7667. This device utilizes high voltage Schottky logic to convert TTL signals to high speed outputs up to 18V. The totem pole outputs have 3A peak current capability, which enables them to drive 1000pF loads in typically less than 25ns. These speeds make it ideal for driving power MOSFETs and other large capacitive loads requiring high speed switching.

In addition to the standard packages, Linfinity offers the 16-pin SOIC (DW package) for commercial and industrial applications, and the Hermetic TO-66 (R package) for military use. These packages offer improved thermal performance for applications requiring high frequencies and/or high peak currents.

KEY FEATURES

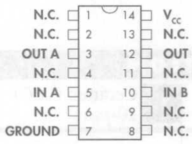
- PIN-FOR-PIN COMPATIBLE WITH DS0026, TSC426 AND ICL7667
- TOTEM POLE OUTPUTS WITH 3.0A PEAK CURRENT CAPABILITY
- SUPPLY VOLTAGE TO 22V
- RISE AND FALL TIME LESS THAN 25ns
- PROPAGATION DELAYS LESS THAN 20ns
- INVERTING HIGH-SPEED, HIGH-VOLTAGE SCHOTTKY LOGIC
- EFFICIENT OPERATION AT HIGH FREQUENCY

HIGH RELIABILITY FEATURES

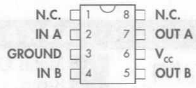
- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

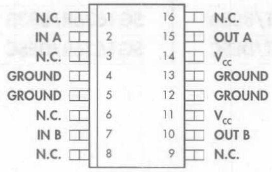
PACKAGE PIN OUTS



J PACKAGE
(Top View)



Y & M PACKAGE
(Top View)



DW PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin	DW Plastic SOIC 16-pin
0 to 70	SG3626J	SG3626Y	SG3626M	SG3626DW
-25 to 85	SG2626J	SG2626Y	SG2626M	SG2626DW
-55 to 150	SG1626J	SG1626Y	—	—
MIL-STD-883	SG1626J/883B	SG1626Y/883B	—	—
DESC	SG1626J/DESC	SG1626Y/DESC	—	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3626DWT)

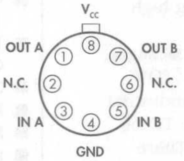
(Package Info / Pin Outs continued on next page)

SG1626/SG2626/SG3626

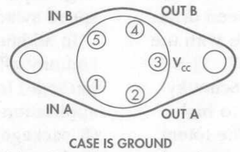
Dual High-Speed Driver

Production Data Sheet

PACKAGE PIN OUTS

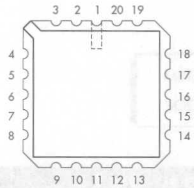


T PACKAGE
(Top View)



Case & Tab are internally connected to substrate ground

R PACKAGE
(Top View)



1. N.C.	11. N.C.
2. GROUND	12. N.C.
3. N.C.	13. OUT B
4. IN A	14. N.C.
5. N.C.	15. V$_{CC}$
6. GROUND	16. N.C.
7. N.C.	17. V$_{CC}$
8. IN B	18. N.C.
9. N.C.	19. OUT A
10. GROUND	20. N.C.

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	T Metal Can TO-99 8-pin	R Metal Can TO-66 5-pin	L Ceramic (LCC) 20-pin
0 to 70	SG3626T	SG3626R	—
-25 to 85	SG2626T	SG2626R	
-55 to 150	SG1626T	SG1626R	—
MIL-STD-883	SG1626T/883B	SG1626R/883B	SG1626L/883B
DESC	SG1626T/DESC	SG1626R/DESC	—

LINFINITY MICROELECTRONICS

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1644/SG2644/SG3644

DUAL HIGH-SPEED DRIVER

PRODUCTION DATA SHEET

DESCRIPTION

The SG1644, SG2644, SG3644 is a dual non-inverting monolithic high speed driver. This device utilizes high voltage Schottky logic to convert TTL signals to high speed outputs up to 18V. The totem pole outputs have 3A peak current capability, which enables them to drive 1000pF loads in typically less than 25ns. These speeds make it ideal for driving power MOSFETs and other large capacitive loads requiring high speed switching.

In addition to the standard packages, Linfinity offers the 16-pin SOIC (DW package) for commercial and industrial applications, and the Hermetic TO-66 (R package) for military use. These packages offer improved thermal performance for applications requiring high frequencies and/or high peak currents.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

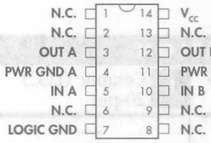
KEY FEATURES

- TOTEM POLE OUTPUTS WITH 3.0A PEAK CURRENT CAPABILITY
- SUPPLY VOLTAGE TO 22V
- RISE AND FALL TIME LESS THAN 25ns
- PROPAGATION DELAYS LESS THAN 20ns
- NON-INVERTING HIGH-SPEED HIGH-VOLTAGE SCHOTTKY LOGIC
- EFFICIENT OPERATION AT HIGH FREQUENCY

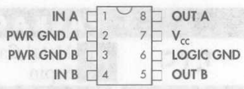
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

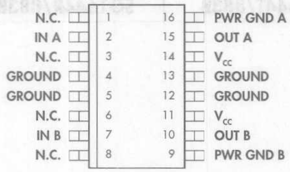
PACKAGE PIN OUTS



J PACKAGE
(Top View)



Y & M PACKAGE
(Top View)



DW PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin	DW Plastic SOIC 16-pin
0 to 70	SG3644J	SG3644Y	SG3644M	SG3644DW
-25 to 85	SG2644J	SG2644Y	SG2644M	SG2644DW
-55 to 150	SG1644J	SGSG1644Y	SG1644M	—
MIL-STD-883	SG1644J/883B	SG1644Y/883B	SG1644M/883B	—

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3644DWT)

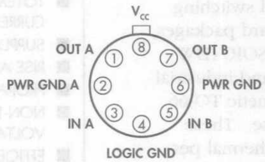
FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG1644/SG2644/SG3644

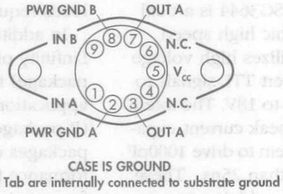
DUAL HIGH-SPEED DRIVER

PRODUCTION DATA SHEET

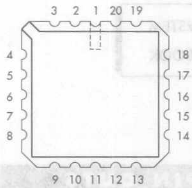
PACKAGE PIN OUTS



T PACKAGE
(Top View)



R PACKAGE
(Top View)



1. N.C.	11. N.C.
2. PWR GND A	12. N.C.
3. N.C.	13. OUT B
4. IN A	14. N.C.
5. N.C.	15. V_{CC}
6. LOGIC GND	16. N.C.
7. N.C.	17. V_{CC}
8. IN B	18. N.C.
9. N.C.	19. OUT A
10. PWR GND B	20. N.C.

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	T Metal Can TO-99 8-pin	R Metal Can TO-66 5-pin	L Ceramic (LCC) 20-pin
0 to 70	SG3644T	SG3644R	—
-25 to 85	SG2644T	SG2644R	—
-55 to 150	SG1644T	SG1644R	—
MIL-STD-883	SG1644T/883B	SG1644R/883B	SG1644L/883B

LINFINITY MICROELECTRONICS

LIN Doc #: 1825

SG1825C/SG2825C/SG3825C

High-Speed Current-Mode PWM

LINFINITY MICROELECTRONICS

The Infinite Power of Innovation

Not Recommended for New Designs

DESCRIPTION

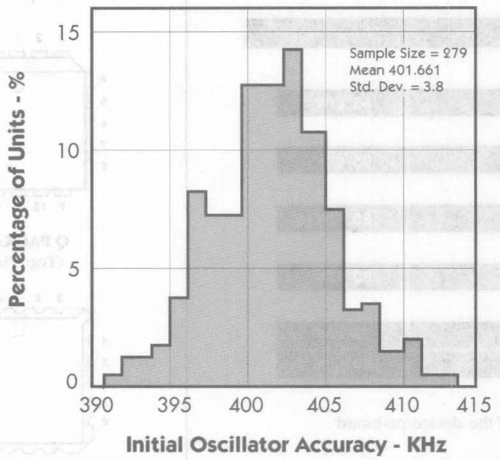
The SG1825C is a high-performance pulse width modulator optimized for high frequency current-mode power supplies. Included in the controller are a precision voltage reference, micropower start-up circuitry, soft-start, high-frequency oscillator, wideband error amplifier, fast current-limit comparator, full double-pulse suppression logic, and dual totem-pole output drivers. Innovative circuit design and an advanced linear Schottky process result in very short propagation delays through the current limit comparator, logic, and output drivers. This device can be used to implement either current-mode or voltage-mode switching power supplies. It also is useful as a series-resonant controller to frequencies beyond 1MHz. The SG1825C is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2825C is characterized for the industrial range of -25°C to 85°C, and the SG3825C is selected for the commercial range of 0°C to 70°C.

KEY FEATURES

- **IMPROVED REFERENCE INITIAL TOLERANCE** (±1% max.)
- **IMPROVED OSCILLATOR INITIAL ACCURACY** (±3% typ.)
- **IMPROVED STARTUP CURRENT** (500µA typ.)
- **PROP DELAY TO OUTPUTS** (50ns typ.)
- 10V TO 30V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 2MHZ OSCILLATOR CAPABILITY
- 1.5A PEAK TOTEM-POLE DRIVERS
- U.V. LOCKOUT WITH HYSTERESIS
- NO OUTPUT DRIVER "FLOAT"
- PROGRAMMABLE SOFTSTART
- DOUBLE-PULSE SUPPRESSION LOGIC
- WIDEBAND LOW-IMPEDANCE ERROR AMPLIFIER
- CURRENT-MODE OR VOLTAGE-MODE CONTROL
- WIDE CHOICE OF HIGH-FREQUENCY PACKAGES

PRODUCT HIGHLIGHT

INITIAL OSCILLATOR ACCURACY



HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE ORDER INFORMATION

T_J (°C)	N Plastic DIP 16-pin	DW Plastic Wide SOIC 16-pin	Q Plastic LCC 20-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3825CN	SG3825CDW	SG3825CQ	SG3825CJ	—
-25 to 85	SG2825CN	SG2825CDW	SG2825CQ	SG2825CJ	—
-55 to 125	—	—	—	SG1825CJ	SG1825CL
MIL-STD-883	—	—	—	SG1825CJ/883B	SG1825CL/883B
DESC	—	—	—	SG1825CJ/DESC	SG1825CL/DESC

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3825CDWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 Western Avenue, Garden Grove, CA. 92841

SG1825C/SG2825C/SG3825C

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage (V_{IN} and V_C)	30V
Analog Inputs:	
Error Amplifier and Ramp	-0.3V to 7.0V
Softstart and I_{LIM}/S.D.	-0.3V to 6.0V
Digital Input (Clock)	1.5V to 6.0V
Driver Outputs	-0.3V to V_C+1.5V
Source / Sink Output Current (each output):	
Continuous	0.5A
Pulse, 500ns	2.0A
Softstart Sink Current	20mA
Clock Output Current	5mA
Error Amplifier Output Current	5mA
Oscillator Charging Current	5mA
Operating Junction Temperature:	
Hermetic (J, L Package)	150°C
Plastic (DW, N, Q Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (soldering, 10 seconds)	300°C

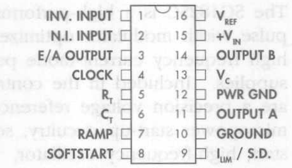
Note 1. Exceeding these ratings could cause damage to the device.

THERMAL DATA

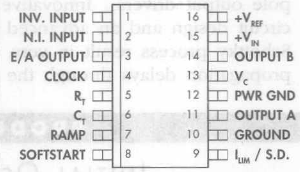
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W
DW PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W
Q PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W
J PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W
L PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

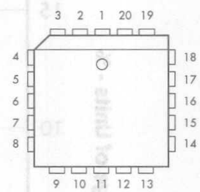
PACKAGE PIN OUTS



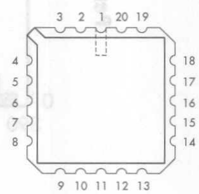
J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



Q PACKAGE
(Top View)



L PACKAGE
(Top View)

1. N.C.	11. N.C.
2. INV. INPUT	12. I_{LIM} / S.D.
3. N.I. INPUT	13. GROUND
4. E/A OUTPUT	14. OUTPUT A
5. CLOCK	15. PWR GND
6. N.C.	16. N.C.
7. R_T	17. V_C
8. C_T	18. OUTPUT B
9. RAMP	19. $+V_{IN}$
10. SOFTSTART	20. V_{REF}

LINFINITY
MICROELECTRONICS

SG1825C/SG2825C/SG3825C

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage Range		10		30	V
Voltage Amp Common Mode Range		1.5		5.5	V
Ramp Input Voltage Range		0		5.0	V
Current Limit / Shutdown Voltage Range		0		4.0	V
Source / Sink Output Current					
Continuous			200		mA
Pulse, 500ns			1.0		A
Voltage Reference Output Current		1		10	mA
Oscillator Frequency Range		4		1500	kHz
Oscillator Charging Current		0.030		3	mA
Oscillator Timing Resistor	R_T	1		100	kΩ
Oscillator Timing Capacitor	C_T	0.470		10	nF
Operating Ambient Temperature Range:					
SG1825C	T_A	0		70	°C
SG2825C	T_A	-25		85	°C
SG3825C	T_A	-55		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG3825C with 0°C ≤ T_A ≤ 70°C, SG2825C with -25°C ≤ T_A ≤ 85°C, SG1825C with -55°C ≤ T_A ≤ 125°C, and V_{IN}=V_C=15V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG1825C/2825C Min.	Typ.	Max.	SG3825C Min.	Typ.	Max.	Units
Reference Section									
Output Voltage		T_J = 25°C, I_L = 1mA	5.05	5.10	5.15	5.05	5.10	5.15	V
Line Regulation		V_{IN} = 10 to 30V		2	15		2	15	mV
Load Regulation		I_L = 1 to 10mA		5	15		5	15	mV
Temperature Stability (Note 3)		Over Operating Temperature		0.2	0.4		0.2	0.4	mV/°C
Total Output Range (Note 3)		Over Line, Load, and Temperature	5.00		5.20	5.00		5.20	V
Output Noise Voltage (Note 3)		f = 10Hz to 10kHz, I_L = 0mA		50	200		50		μV_{RMS}
Long Term Stability (Notes 3 &4)		T_J = 125°C, t = 1000hrs		5	25		5	25	mV
Short Circuit Current		V_{REF} = 0V	-15	-50	-100	-15	-50	-100	mA
Oscillator Section (Note 5)									
Initial Accuracy		T_J = 25°C, C_{CLK} ≤ 10pF	370	400	430	370	400	430	kHz
Voltage Stability		V_{IN} = 10 to 30V		0.2	2		0.2	2	%
Temperature Stability (Note 3)		Over Rated Operating Temperature		5	8		5	8	%
Total Frequency Limits (Note 3)		Over Line and Temperature	350		450	350		450	kHz
Minimum Frequency		R_T = 100KΩ, C_T = 0.01μF			4			4	kHz
Maximum Frequency		R_T = 1KΩ, C_T = 470pF	1.5			1.5			MHz
Clock High Level		I_{CLK} = -1mA	3.9	4.5		3.9	4.5		V
Clock Low Level		I_{CLK} = -1mA		2.3	2.9		2.3	2.9	V
Ramp Peak Voltage			2.6	2.8	3.0	2.6	2.8	3.0	V
Ramp Valley Voltage			0.7	1.0	1.25	0.7	1.0	1.25	V
Valley-to-Peak Amplitude			1.6	1.8	2.0	1.6	1.8	2.0	V

Note 3. This parameter is guaranteed by design and process control, but is not 100% tested in production.
Note 4. This parameter is non-accumulative, and represents the random fluctuation of the reference voltage within some error band when observed over any 1000 hour period of time.

LINFINITY MICROELECTRONICS

SG1825C/SG2825C/SG3825C

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

ELECTRICAL CHARACTERISTICS (Cont'd.)

Parameter	Symbol	Test Conditions	SG1825C/2825C			SG3825C			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Error Amplifier Section (Note 6)									
Input Offset Voltage		$R_S \leq 2K\Omega$, $V_{ERROR} = 2.5V$			15			15	mV
Input Bias Current		$V_{ERROR} = 2.5V$		0.6	3		0.6	3	µA
Input Offset Current		$V_{ERROR} = 2.5V$		0.1	1		0.1	1	µA
DC Open Loop Gain	A_{VOL}	$V_{ERROR} = 1$ to $4V$	60	95		60	95		dB
Common Mode Rejection		Over Rated Voltage Range, $V_{ERROR} = 2.5V$	75	95		75	95		dB
Power Supply Rejection		$V_{IN} = 10V$ to $30V$, $V_{ERROR} = 2.5V$	85	110		85	110		dB
Output Sink Current		$V_{ERROR} = 1V$	1	2.5		1	2.5		mA
Output Source Current		$V_{ERROR} = 4V$	-0.5	-1.3		-0.5	-1.3		mA
Output High Voltage		$I_{ERROR} = -0.5mA$	4.0	4.7	5.0	4.0	4.7	5.0	V
Output Low Voltage		$I_{ERROR} = 1mA$	0	0.5	1.0	0	0.5	1.0	V
Unity Gain Bandwidth (Note 3)		$A_{VOL} = 0dB$	3	5.5		3	5.5		MHz
Slew Rate (Note 3)			6			6			V/µsec
PWM Comparator Section (Note 5 & 7)									
Ramp Input Bias Current				-1	-5		-1	-5	µA
Minimum Duty Cycle		$V_{ERROR} = 1V$			0			0	%
Maximum Duty Cycle (Note 8)		$V_{ERROR} = 4V$	85			85			%
Zero Duty Cycle Threshold			1.1	1.25		1.1	1.25		V
Delay to Driver Output (Note 3)		$V_{RAMP} = 0V$ to $2V$, $V_{ERROR} = 2V$		50	80		50	80	ns
Softstart Section									
C_{SS} Charge Current		$V_{SOFTSTART} = 0.5V$	3	9	20	3	9	20	µA
C_{SS} Discharge Current		$V_{SOFTSTART} = 1.0V$	1			1			mA
Current Limit / Shutdown Section (Note 9)									
I_{LIM} Input Bias Current					±15			±10	µA
Current Limit Threshold			0.9	1.0	1.1	0.9	1.0	1.1	V
Shutdown Threshold			1.25	1.40	1.55	1.20	1.40	1.55	V
Delay to Driver Output (Note 3)		$V_{SHUTDOWN} = 0V$ to $1.2V$		50	80		50	80	ns
Output Drivers Section (each output)									
Output Low Level		$I_{SINK} = 20mA$		0.25	0.40		0.25	0.40	V
		$I_{SINK} = 200mA$		1.2	2.0		1.2	2.0	V
Output High Level		$I_{SOURCE} = 20mA$	13.0	13.5		13.0	13.5		V
		$I_{SOURCE} = 200mA$	12.0	13.0		12.0	13.0		V
V_C Standby Current		$V_C = 30V$		150	500		150	500	µA
Output Rise / Fall Time (Note 3)		$C_L = 1000pF$		30	60		30	60	ns
Undervoltage Lockout Section									
Start Threshold Voltage			8.8	9.2	9.7	8.8	9.2	9.7	V
UV Lockout Hysteresis			0.4	0.8	1.2	0.4	0.8	1.2	V
Supply Current Section (Note 5)									
Start Up Current		$V_{IN} = 8V$		0.5	1.2		0.5	1.2	mA
Operating Current		V_{INV}, V_{RAMP}, $V(I_{LIM}/S.D.) = 0V$, $V_{N.I.} = 1V$		22	33		22	33	mA

Note 5. $F_{OSC} = 400kHz$ ($R_T = 3.65k\Omega$, $C_T = 1.0nF$).
Note 6. $V_{CM} = 1.5V$ to $5.5V$.
Note 7. $V_{RAMP} = 0V$, unless otherwise specified.
Note 8. 100% duty cycle is defined as a pulsewidth equal to one oscillator period.
Note 9. $V(I_{LIM}/S.D.) = 0V$ to $4.0V$, unless otherwise specified.

LINFINITY MICROELECTRONICS

SG1825C/SG2825C/SG3825C

HIGH-SPEED CURRENT-MODE PWM

NOT RECOMMENDED FOR NEW DESIGNS

BLOCK DIAGRAM

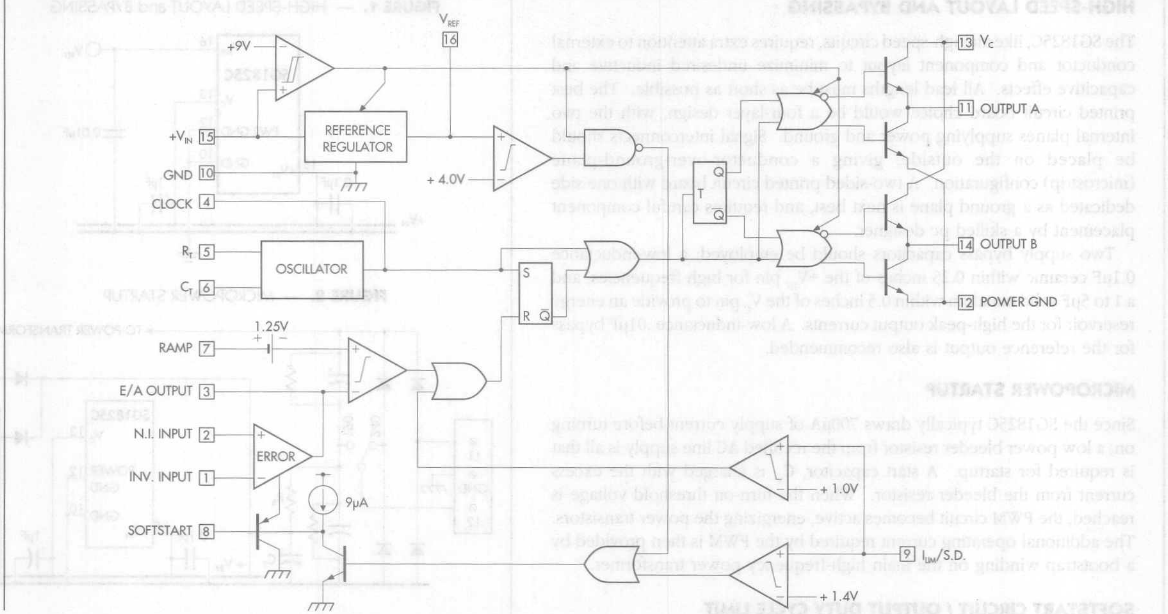


FIGURE INDEX

Application Circuits

FIGURE #

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

HIGH-SPEED LAYOUT AND BYPASSING

The SG1825C, like all high-speed circuits, requires extra attention to external conductor and component layout to minimize undesired inductive and capacitive effects. All lead lengths must be as short as possible. The best printed circuit board choice would be a four-layer design, with the two internal planes supplying power and ground. Signal interconnects should be placed on the outside, giving a conductor-over-ground-plane (microstrip) configuration. A two-sided printed circuit board with one side dedicated as a ground plane is next best, and requires careful component placement by a skilled pc designer.

Two supply bypass capacitors should be employed: a low-inductance 0.1µF ceramic within 0.25 inches of the $+V_{IN}$ pin for high frequencies, and a 1 to 5µF solid tantalum within 0.5 inches of the V_C pin to provide an energy reservoir for the high-peak output currents. A low-inductance .01µF bypass for the reference output is also recommended.

MICROPOWER STARTUP

Since the SG1825C typically draws 700µA of supply current before turning on, a low power bleeder resistor from the rectified AC line supply is all that is required for startup. A start capacitor, C_S, is charged with the excess current from the bleeder resistor. When the turn-on threshold voltage is reached, the PWM circuit becomes active, energizing the power transistors. The additional operating current required by the PWM is then provided by a bootstrap winding on the main high-frequency power transformer.

SOFTSTART CIRCUIT / OUTPUT DUTY CYCLE LIMIT

The softstart pin of the SG1825C is held low when either the chip is in the micropower mode, or when a voltage greater than +1.4 volts is present at the $I_{LIM/S.D.}$ pin. The maximum positive swing of the voltage error amplifier is clamped to the Softstart pin voltage, providing a ramp-up of peak charging currents in the power semiconductors at turn-on.

In some cases, the duration of the Shutdown signal can be too short to fully discharge the softstart capacitor. The illustrated resistor/discrete PNP transistor configuration can be used to shorten the discharge time by a factor of 50 or more. When the internal discharge transistor in the SG1825C turns on, current will flow through surge limit resistor R1. As the resistor drop approaches 0.6 volts, the external PNP turns on, providing a low resistance discharge path for the energy in the softstart capacitor. The capacitor will be rapidly discharged to +0.7 volts, which corresponds to zero duty cycle in the pulse width modulator.

FREQUENCY SYNCHRONIZATION

Two or three SG1825C oscillators may be locked together with the interconnection scheme shown, if the devices are within an inch or so of each other. A master unit is programmed for desired frequency with R_T and C_T as usual. The oscillators in the slave units are disabled by grounding C_T and by connecting R_T to V_{REF}. The logic in the slave units is locked to the clock of the master with the wire-OR connection shown.

Many SG1825Cs can be locked to a master system clock by wiring the oscillators as slave units, and distributing the master clock to each using a tree-fanout geometry.

APPLICATION FIGURES

FIGURE 1. — HIGH-SPEED LAYOUT and BYPASSING

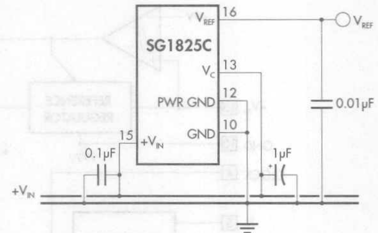


FIGURE 2. — MICROPOWER STARTUP

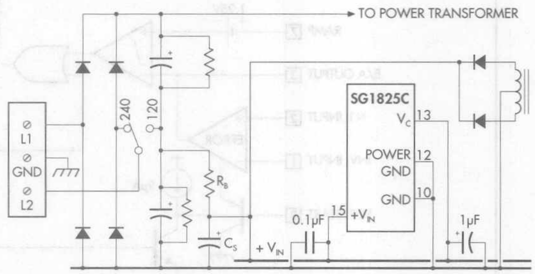


FIGURE 3. — SOFTSTART FAST RESET

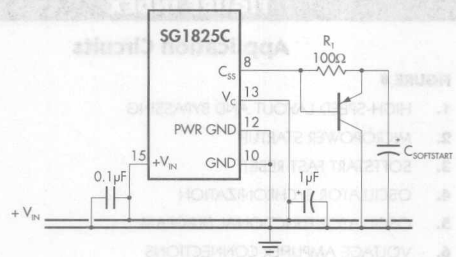
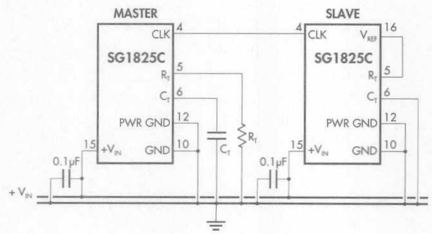


FIGURE 4. — OSCILLATOR SYCHRONIZATION



LINFINITY
MICROELECTRONICS

APPLICATION INFORMATION

OSCILLATOR

The oscillator frequency is programmed by external timing components R_T and C_T. A nominal +3.0 volts appears at the R_T pin. The current flowing through R_T is mirrored internally with a 1:1 ratio. This causes an identical current to flow out the C_T pin, charging the timing capacitor and generating a linear ramp. When the upper threshold of +2.8 volts is reached, a discharge network reduces the ramp voltage to +1.0, where a new charge cycle begins.

The Clock output pin is LOW (+2.3 volts) during the charge cycle, and HIGH (+4.5 volts) during the discharge cycle. The Clock pin is driven by an NPN emitter follower, and so can be wire-ORed. Each Clock pin can drive a 1mA load. Since the internal current-source pulldown is approximately 400µA, the DC fan-out to other SG1825C Clock pins is at least two.

The type of capacitor selected for C_T is very important. At high frequencies, non-ideal characteristics such as effective series resistance (ESR), effective series inductance (ESL), dielectric loss and dielectric absorption all affect frequency accuracy and stability. RF capacitors such as silver mica, glass, polystrene, or COG ceramics are recommended. Avoid high-K ceramics, which work best in DC bypass applications.

ERROR AMPLIFIER

The voltage error amplifier is a true operational amplifier with low-impedance output, and can be gain-stabilized using conventional feedback techniques. The typical DC open-loop gain is 95dB, with a single low-frequency pole at 100Hz.

The input connections to the error amplifier are determined by the polarity of the power supply output voltage. For positive supplies, the common-mode voltage is +5.1 volts and the feedback connections in Figure A are used. With negative outputs, the common-mode voltage is half the reference, and the feedback divider is connected between the negative output and the +5.1 volt reference as shown in Figure B.

OUTPUT DRIVER

The output drivers are designed to provide up to 1.5 Amps peak output current. To minimize ringing on the output waveform, which can be destructive to both the power MOSFET and the PWM chip, the series inductance seen by the drivers should be as low as possible.

One solution is to keep the distance between the PWM and MOSFET gate as short as possible, and to use carbon composition series damping resistors. A Faraday shield to intercept radiated EMI from the power transistors is usually required with its choice.

A second approach is to place the MOSFETs some distance from the PWM chip, and use a series-terminated transmission line to preserve drive pulse fidelity. This will minimize noise radiated back to the sensitive analog circuitry of the SG1825C. A Faraday shield may also be required.

If the drivers are connected to an isolation transformer, or if kickback through C_{GD} of the MOSFET is severe, clamp diodes may be required. 1 Amp peak Schottky diodes will limit undershoot to less than -0.3 volts.

APPLICATION FIGURES

FIGURE 5. — OSCILLATOR FUNCTIONAL DIAGRAM

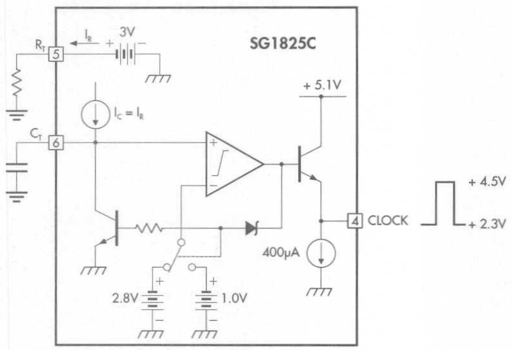


FIGURE 6. — VOLTAGE AMPLIFIER CONNECTIONS

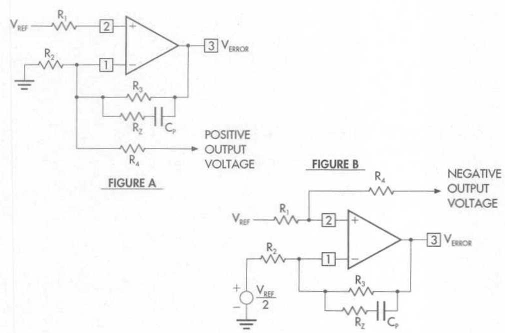
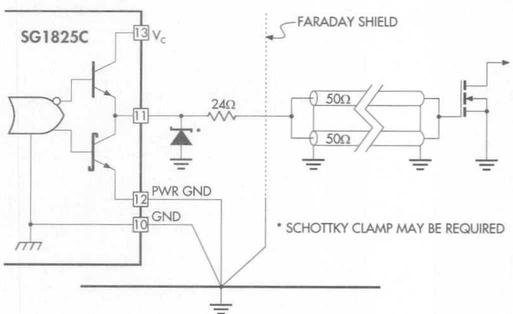


FIGURE 7. — DRIVING SHIELDED CABLE



Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1842/SG1843 Series

CURRENT MODE PWM CONTROLLER

PRODUCTION DATA SHEET

DESCRIPTION

The SG1842/43 family of control IC's provides all the necessary features to implement off-line fixed frequency, current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch.

The bandgap reference is trimmed to ±1% over temperature. Oscillator discharge current is trimmed to less than ±10%. The SG1842/43 has under-voltage lockout, current limiting circuitry and start-up current of less than 1mA.

The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N channel device.

The SG1842/43 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2842/43 is specified for the industrial range of -25°C to 85°C, and the SG3842/43 is designed for the commercial range of 0°C to 70°C.

KEY FEATURES

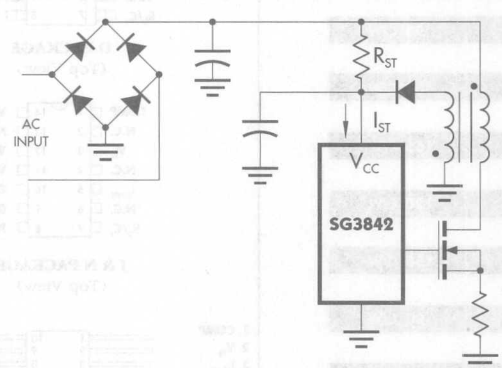
- OPTIMIZED FOR OFF-LINE CONTROL
- LOW START-UP CURRENT (<1mA)
- AUTOMATIC FEED FORWARD COMPENSATION
- TRIMMED OSCILLATOR DISCHARGE CURRENT
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH 6V HYSTERESIS (SG1842 only)
- DOUBLE-PULSE SUPPRESSION
- HIGH-CURRENT TOTEM-POLE OUTPUT (1AMP PEAK)
- INTERNALLY TRIMMED BANDGAP REFERENCE
- 500KHZ OPERATION
- UNDERVOLTAGE LOCKOUT
  SG1842 - 16 volts
  SG1843 - 8.4 volts
- LOW SHOOT-THROUGH CURRENT <75mA OVER TEMPERATURE

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- SCHEDULED FOR MIL-M38510 QPL LISTING
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF SG3842 IN A FLYBACK CONVERTER



PACKAGE ORDER INFORMATION

T_A (°C)	M Ceramic DIP 8-pin	N Plastic DIP 14-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	J Ceramic DIP 14-pin	F Cer. Flatpack 10-pin	L Ceramic LCC 20-pin
0 to 70	SG3842M	SG3842N	SG3842DM	SG3842D	SG3842Y	SG3842J	—	—
	SG3843M	SG3843N	SG3843DM	SG3843D	SG3843Y	SG3843J	—	—
-25 to 85	SG2842M	SG2842N	SG2842DM	SG2842D	SG2842Y	SG2842J	—	—
	SG2843M	SG2843N	SG2843DM	SG2843D	SG2843Y	SG2843J	—	—
-55 to 125	—	—	—	—	SG1842Y	SG1842J	—	SG1842L
	—	—	—	—	SG1843Y	SG1843J	—	SG1843L
MIL-STD/883	—	—	—	—	SG1842Y/883B	SG1842J/883B	—	SG1842L/883B
	—	—	—	—	SG1843Y/883B	SG1843J/883B	—	SG1843L/883B
DESC	—	—	—	—	SG1842Y/DESC	SG1842J/DESC	SG1842F/DESC	SG1842L/DESC
			—	—	SG1843Y/DESC	SG1843J/DESC	SG1843F/DESC	SG1843L/DESC

Note: All surface-mount packages are available in Tape & Reel.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG1842/SG1843 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Notes 1 & 2)

Supply Voltage (I_{CC} < 30mA) .... Self Limiting
Supply Voltage (Low Impedance Source) 30V
Output Current (Peak) .... ±1A
Output Current (Continuous) 350mA
Output Energy (Capacitive Load) 5µJ
Analog Inputs (Pins 2, 3) .... -0.3V to +6.3V
Error Amp Output Sink Current 10mA
Power Dissipation at T_A = 25°C (DIL-8) 1W
Operating Junction Temperature
Hermetic (J, Y, F, L Packages) .... 150°C
Plastic (N, M, D, DM Packages) .... 150°C
Storage Temperature Range .... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device.
Note 2. All voltages are with respect to Pin 5. All currents are positive into the specified terminal.

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

D PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Y PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W

J PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

F PACKAGE:

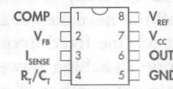
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	80°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	145°C/W

L PACKAGE:

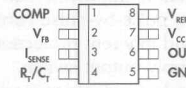
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

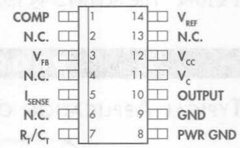
PACKAGE PIN OUTS



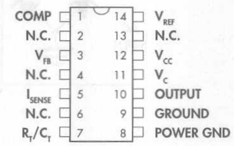
M & Y PACKAGE
(Top View)



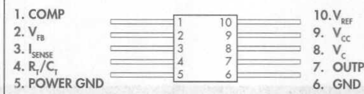
DM PACKAGE
(Top View)



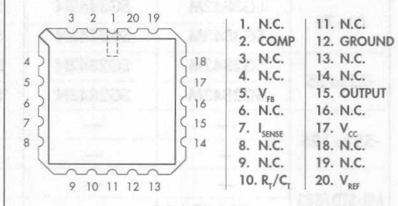
D PACKAGE
(Top View)



J & N PACKAGE
(Top View)



F PACKAGE
(Top View)



L PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 3)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage Range			30		V
Output Current (Peak)			±1		A
Output Current (Continuous)			200		mA
Analog Inputs (Pin 2, Pin 3)		0		2.6	V
Error Amp Output Sink Current			5		mA
Oscillator Frequency Range		0.1		500	kHz
Oscillator Timing Resistor	R_T	0.52		150	KΩ
Oscillator Timing Capacitor	C_T	0.1		1.0	µF
Operating Ambient Temperature Range:					
SG1842/43		-55		125	°C
SG2842/43		-25		85	°C
SG3842/43		0		70	°C

Note 3. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1842/SG1843 with -55°C ≤ T_A ≤ 125°C, SG2842/SG2843 with -25°C ≤ T_A ≤ 85°C, SG3842/SG3843 with 0°C ≤ T_A ≤ 70°C, V_{CC} = 15V (Note 7), R_T = 10kΩ, and C_T = 3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG1842/43 Min.	Typ.	Max.	SG2842/43 Min.	Typ.	Max.	SG3842/43 Min.	Typ.	Max.	Units
Reference Section												
Output Voltage		T_J = 25°C, I_O = 1mA	4.95	5.00	5.05	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation		12 ≤ V_{IN} ≤ 25V		6	20		6	20		6	20	mV
Load Regulation		1 ≤ I_O ≤ 20mA		6	25		6	25		6	25	mV
Temperature Stability (Note 4)				0.2	0.4		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation (Note 4)		Line, Load, Temp.	4.90		5.10	4.90		5.10	4.82		5.18	V
Output Noise Voltage (Note 4)	V_N	10Hz ≤ f ≤ 10kHz, T_J = 25°C		50			50			50		µV
Long Term Stability (Note 4)		T_A = 125°C, 1000hrs		5	25		5	25		5	25	mV
Output Short Circuit			-30	-100	-180	-30	-100	-180	-30	-100	-180	mA
Oscillator Section												
Initial Accuracy		T_J = 25°C	47	52	57	47	52	57	47	52	57	kHz
Voltage Stability		12 ≤ V_{CC} ≤ 25V		0.2	1		0.2	1		0.2	1	%
Temperature Stability (Note 4)		T_{MIN} ≤ T_A ≤ T_{MAX}		5			5			5		%
Amplitude		$V_{RT/CT}$ (Peak to Peak)		1.7			1.7			1.7		V
Discharge Current		T_J = 25°C	7.8	8.3	8.8	7.5	8.4	9.3	7.5	8.4	9.3	mA
		T_{MIN} ≤ T_A ≤ T_{MAX}	7.0		9.0	7.2		9.5	7.2		9.5	mA
Error Amp Section												
Input Voltage		V_{COMP} = 2.5V	2.45	2.50	2.55	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current				-0.3	-1		-0.3	1		-0.3	-2	µA
Open Loop Gain	A_{VOL}	2 ≤ V_O ≤ 4V	65	90		65	90		65	90		dB
Unity Gain Bandwidth (Note 4)		T_J = 25°C	0.7	1		0.7	1		0.7	1		MHz
Power Supply Rejection Ratio	PSRR	12 ≤ V_{CC} ≤ 25V	60	70		60	70		60	70		dB
Output Sink Current		V_{FB} = 2.7V, V_{COMP} = 1.1V	2	6		2	6		2	6		mA
Output Source Current		V_{FB} = 2.3V, V_{COMP} = 5V	-0.5	-0.8		-0.5	-0.8		-0.5	-0.8		mA
V_{OUT} High		V_{FB} = 2.3V, R_L = 15K to gnd	5	6		5	6		5	6		V
V_{OUT} Low		V_{FB} = 2.7V, R_L = 15K to V_{REF}		0.7	1.1		0.7	1.1		0.7	1.1	V

(Electrical Characteristics continue next page.)

SG1842/SG1843 Series

Current-Mode PWM Controller

Production Data Sheet

ELECTRICAL CHARACTERISTICS (Cont'd.)

Parameter	Symbol	Test Conditions	SG1842/43			SG2842/43			SG3842/43			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Current Sense Section												
Gain (Notes 5 & 6)			2.85	3	3.15	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 5)		$V_{COMP} = 5V$	0.9	1	1.1	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 5)	PSRR	$12 \le V_{CC} \le 25V$		70			70			70		dB
Input Bias Current				-2	-10		-2	-10		-2	-10	µA
Delay to Output (Note 4)				150	300		150	300		150	300	ns
Output Section												
Output Low Level		$I_{SINK} = 20mA$		0.1	0.4		0.1	0.4		0.1	0.4	V
		$I_{SINK} = 200mA$		1.5	2.2		1.5	2.2		1.5	2.2	V
Output High Level		$I_{SOURCE} = 20mA$	13	13.5		13	13.5		13	13.5		V
		$I_{SOURCE} = 200mA$	12	13.5		12	13.5		12	13.5		V
Rise Time		$T_J = 25°C, C_L = 1nF$		50	150		50	150		50	150	ns
Fall Time		$T_J = 25°C, C_L = 1nF$		50	150		50	150		50	150	ns
Under-Voltage Lockout Section												
Start Threshold		1842	15	16	17	15	16	17	14.5	16	17.5	V
		1843	7.8	8.4	9.0	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operation Voltage After Turn-On		1842	9	10	11	9	10	11	8.5	10	11.5	V
		1843	7.0	7.6	8.2	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section												
Maximum Duty Cycle			93	95	100	90	95	100	90	95	100	%
Minimum Duty Cycle					0			0			0	%
Power Consumption Section												
Start-Up Current				0.5	1		0.5	1		0.5	1	mA
Operating Supply Current		$V_{FB} = V_{ISENSE} = 0V$		11	17		11	17		11	17	mA
V_{CC} Zener Voltage		$I_{CC} = 25mA$		34			34			34		V

Notes: 4. These parameters, although guaranteed, are not 100% tested in production.
5. Parameter measured at trip point of latch with $V_{VFB} = 0$.
6. Gain defined as: $A = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$; $0 \le V_{ISENSE} \le 0.8V$.
7. Adjust V_{CC} above the start threshold before setting at 15V.

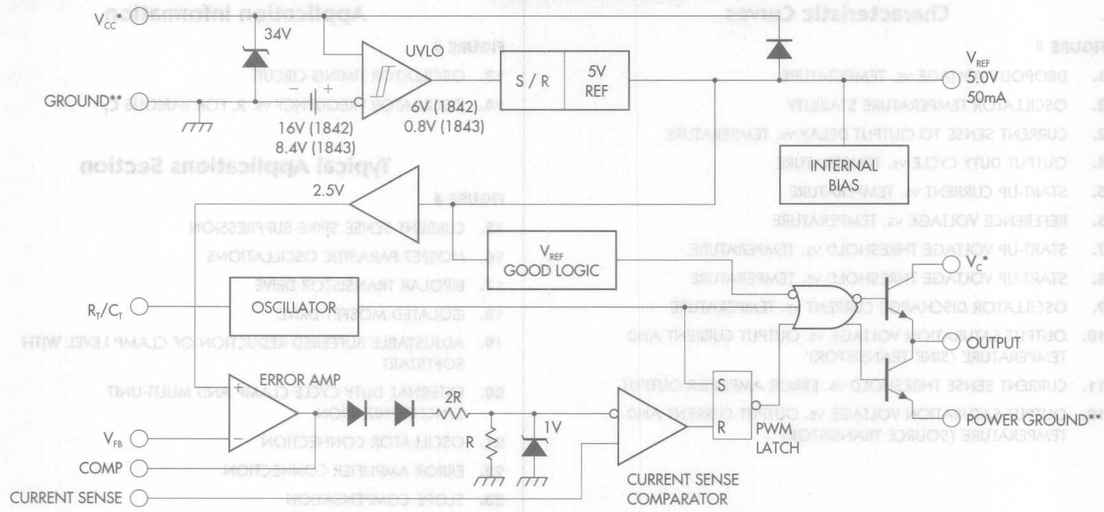
LINFINITY MICROELECTRONICS

SG1842/SG1843 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

BLOCK DIAGRAM



* - V_{CC} and V_C are internally connected for 8 pin packages.
** - POWER GROUND and GROUND are internally connected for 8 pin packages.

SG1842/SG1843 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Information

Typical Applications Section

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — DROPOUT VOLTAGE vs. TEMPERATURE

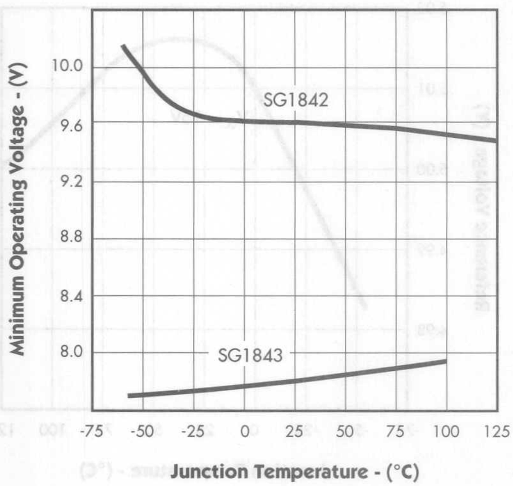


FIGURE 2. — OSCILLATOR TEMPERATURE STABILITY

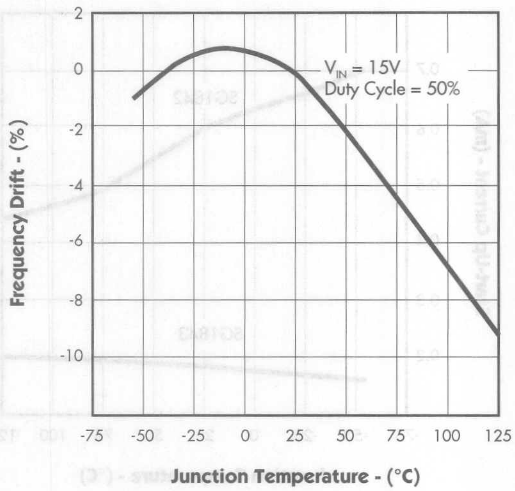


FIGURE 3. — CURRENT SENSE TO OUTPUT DELAY vs. TEMPERATURE

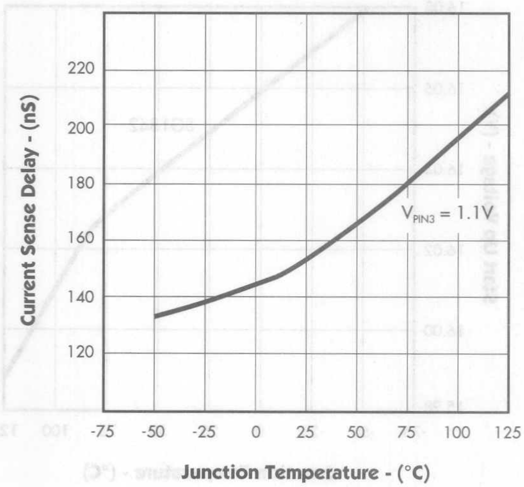
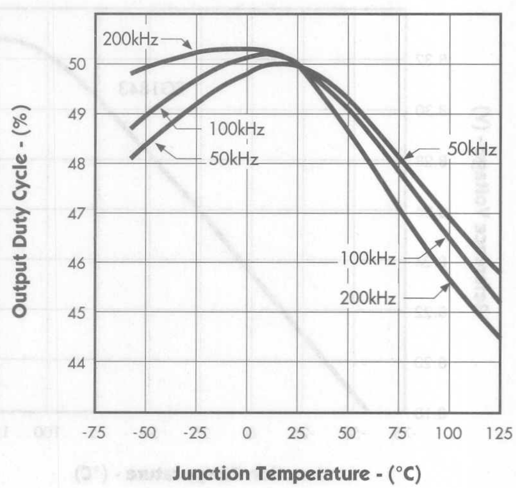


FIGURE 4. — OUTPUT DUTY CYCLE vs. TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 5. — START-UP CURRENT vs. TEMPERATURE

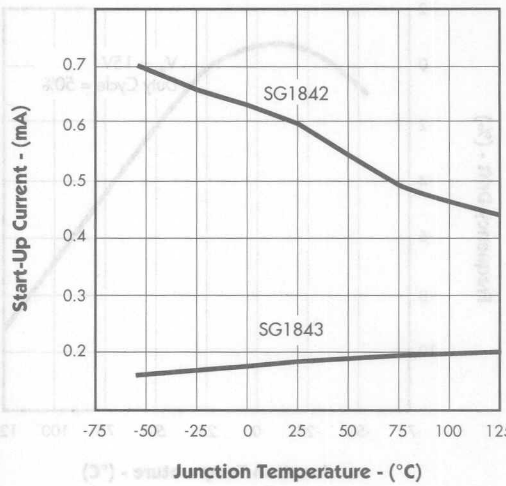


FIGURE 6. — REFERENCE VOLTAGE vs. TEMPERATURE

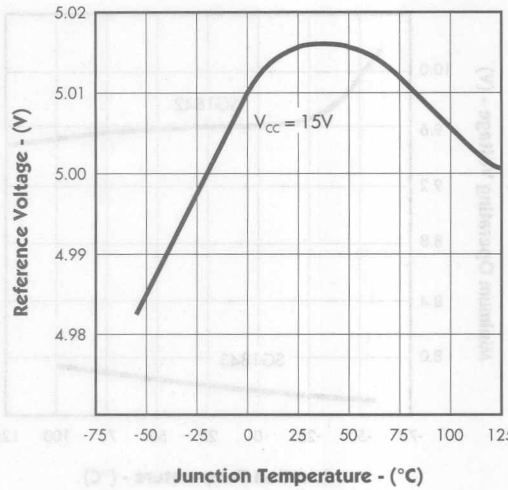


FIGURE 7. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE

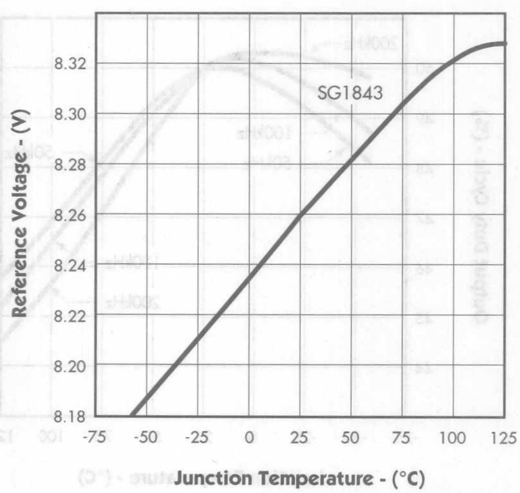
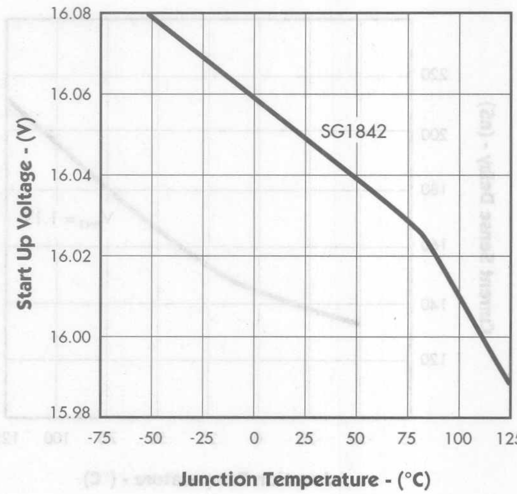


FIGURE 8. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 9. — OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE

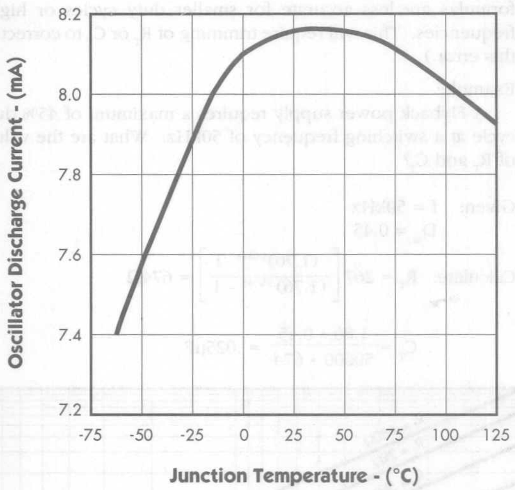


FIGURE 10. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE

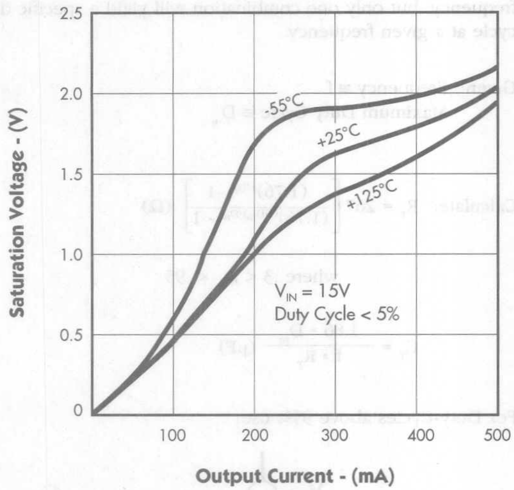


FIGURE 11. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT

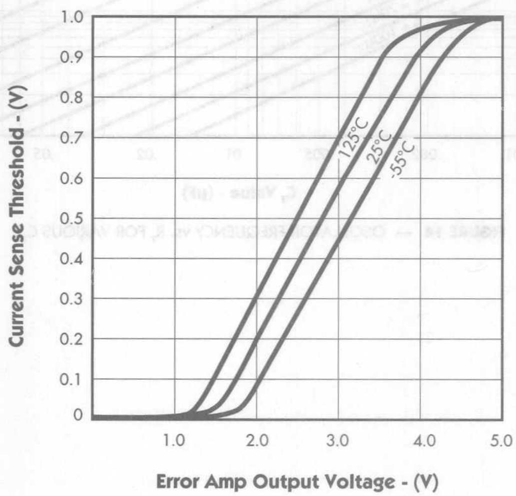
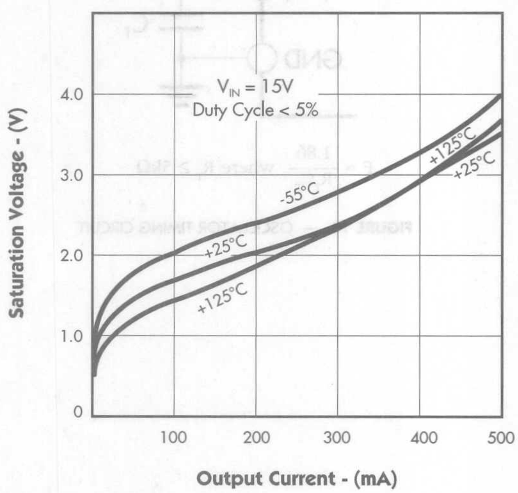


FIGURE 12. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE



APPLICATION INFORMATION

OSCILLATOR

The oscillator of the 1842/43 family of PWM's is designed such that many values of R_T and C_T will give the same oscillator frequency, but only one combination will yield a specific duty cycle at a given frequency.

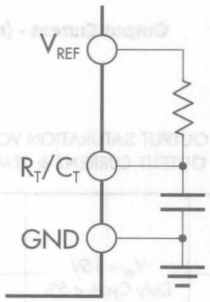
Given: Frequency $\equiv$ f
Maximum Duty Cycle $\equiv D_m$

Calculate:
$$R_T = 267\left[\frac{(1.76)^{1/D_m} - 1}{(1.76)^{(1-D_m)/D_m} - 1}\right] \;(\Omega)$$

where $.3 < D_m < .95$

$$C_T = \frac{1.86 * D_m}{f * R_T} \;(\mu F)$$

For Duty-Cycles above 95% use:



$$F \approx \frac{1.86}{R_T C_T} \quad \text{where } R_T \geq 5k\Omega$$

FIGURE 13 — OSCILLATOR TIMING CIRCUIT

A set of formulas are given to determine the values of R_T and C_T for a given frequency and maximum duty cycle. (Note: These formulas are less accurate for smaller duty cycles or higher frequencies. This will require trimming of R_T or C_T to correct for this error.)

Example:

A Flyback power supply requires a maximum of 45% duty cycle at a switching frequency of 50kHz. What are the values of R_T and C_T?

Given: f = 50kHz
$D_m = 0.45$

Calculate:
$$R_T = 267\left[\frac{(1.76)^{1/.045} - 1}{(1.76)^{.55/.45} - 1}\right] = 674\Omega$$

$$C_T = \frac{1.86 * 0.45}{50000 * 674} = .025\mu F$$

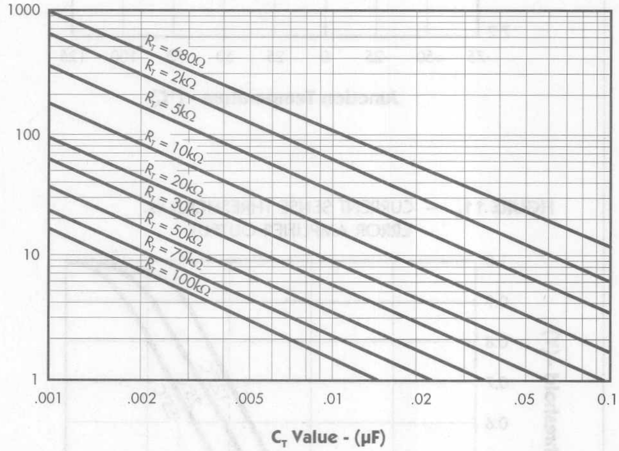


FIGURE 14 — OSCILLATOR FREQUENCY vs. R_T FOR VARIOUS C_T

LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.

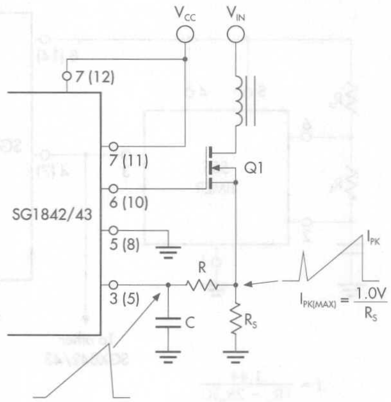


FIGURE 15. — CURRENT-SENSE SPIKE SUPPRESSION

The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

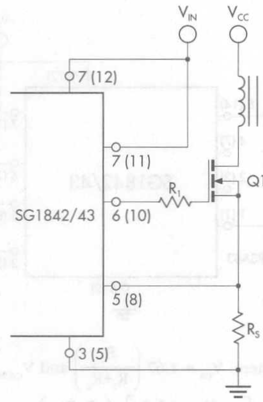


FIGURE 16. — MOSFET PARASITIC OSCILLATIONS

A resistor (R_1) in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

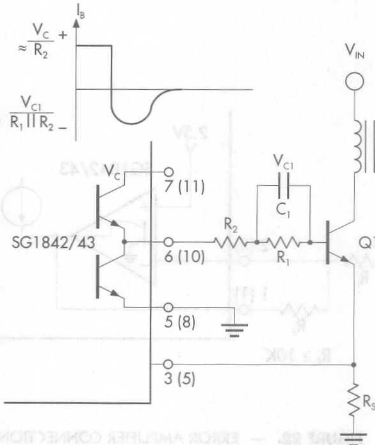
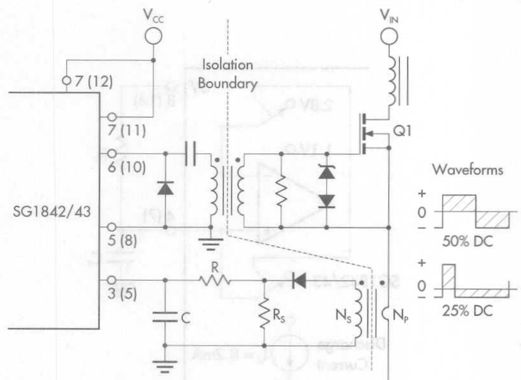


FIGURE 17. — BIPOLAR TRANSISTOR DRIVE

The 1842/43 output stage can provide negative base current to remove base charge of power transistor (Q_1) for faster turn off. This is accomplished by adding a capacitor (C_1) in parallel with a resistor (R_1). The resistor (R_1) is to limit the base current during turn on.

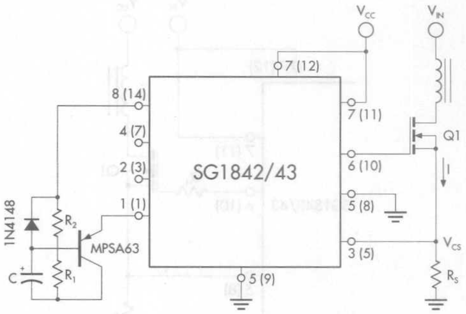


$$I_{PK} = \frac{V\ (\text{PIN } 1) - 1.4}{3R_s} \left(\frac{N_P}{N_S} \right)$$

FIGURE 18. — ISOLATED MOSFET DRIVE

Current transformers can be used where isolation is required between PWM and Primary ground. A drive transformer is then necessary to interface the PWM output with the MOSFET.

TYPICAL APPLICATION CIRCUITS (continued)



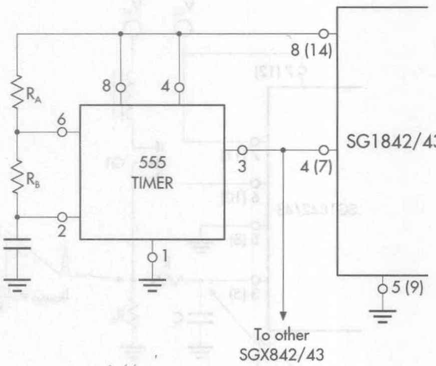
$$I_{PK} = \frac{V_{CS}}{R_S} \quad \text{Where: } V_{CS} = 1.67\left(\frac{R_1}{R_1+R_2}\right) \text{ and } V_{CS.MAX} = 1\text{V (Typ.)}$$

$$t_{SOFTSTART} = -\ln\left[1 - \frac{V_{EAO} - 1.3}{5\left(\frac{R_1}{R_1+R_2}\right)}\right]\left(\frac{R_1 R_2}{R_1+R_2}\right) C$$

where; V_{EAO} ≡ voltage at the Error Amp Output under minimum line and maximum load conditions.

FIGURE 19. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART

Softstart and adjustable peak current can be done with the external circuitry shown above.



$$f = \frac{1.44}{(R_A + 2R_B)C}$$

$$f = \frac{R_B}{R_A + 2R_B}$$

FIGURE 20. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION

Precision duty cycle limiting as well as synchronizing several 1842/1843's is possible with the above circuitry.

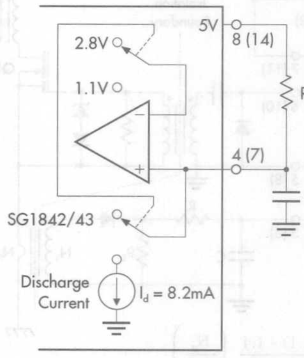


FIGURE 21. — OSCILLATOR CONNECTION

The oscillator is programmed by the values selected for the timing components R_T and C_T. Refer to application information for calculation of the component values.

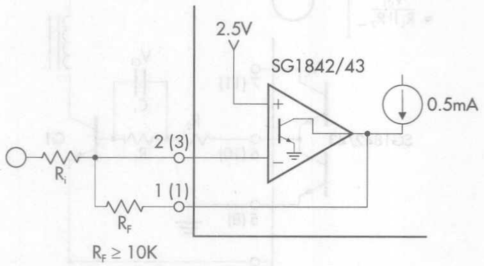


FIGURE 22. — ERROR AMPLIFIER CONNECTION

Error amplifier is capable of sourcing and sinking current up to 0.5mA.

TYPICAL APPLICATION CIRCUITS (continued)

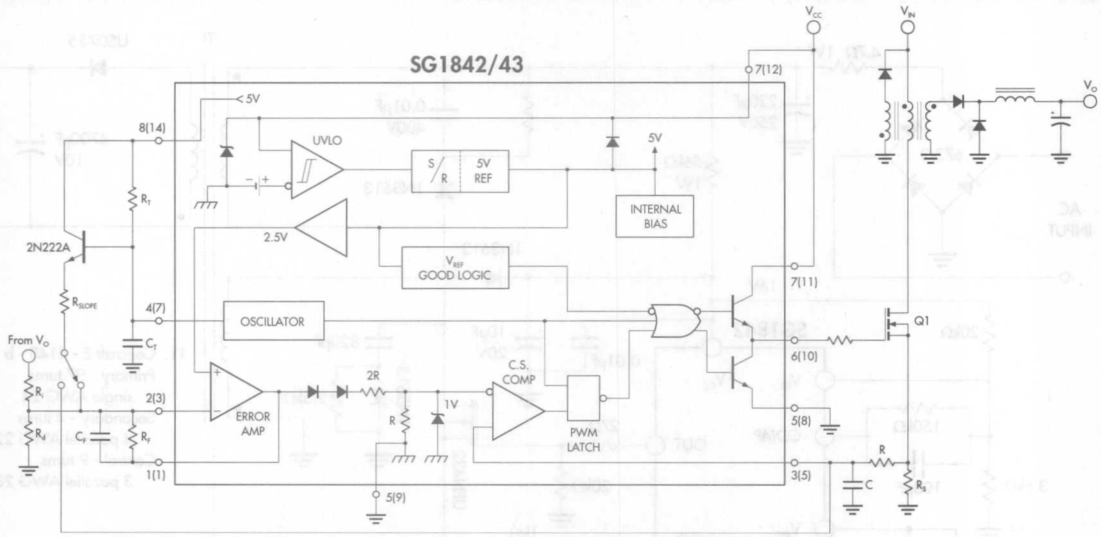


FIGURE 23. — SLOPE COMPENSATION

Due to inherent instability of current mode converters running above 50% duty cycle, a slope compensation should be added to either current sense pin or the error amplifier. Figure 23 shows a typical slope compensation technique.

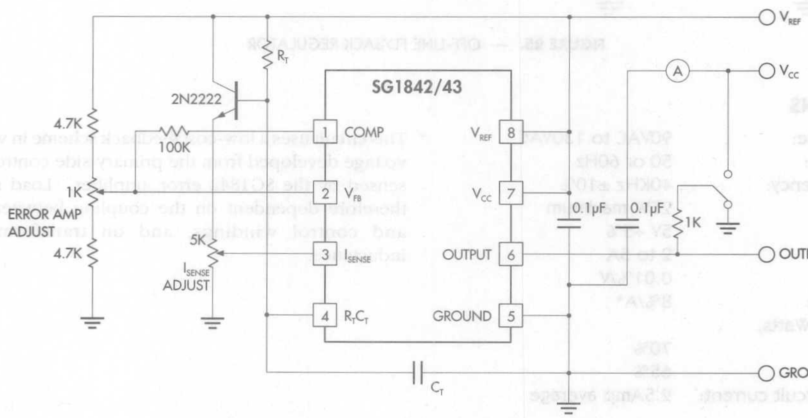


FIGURE 24. — OPEN LOOP LABORATORY FIXTURE

High-peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.

TYPICAL APPLICATION CIRCUITS (continued)

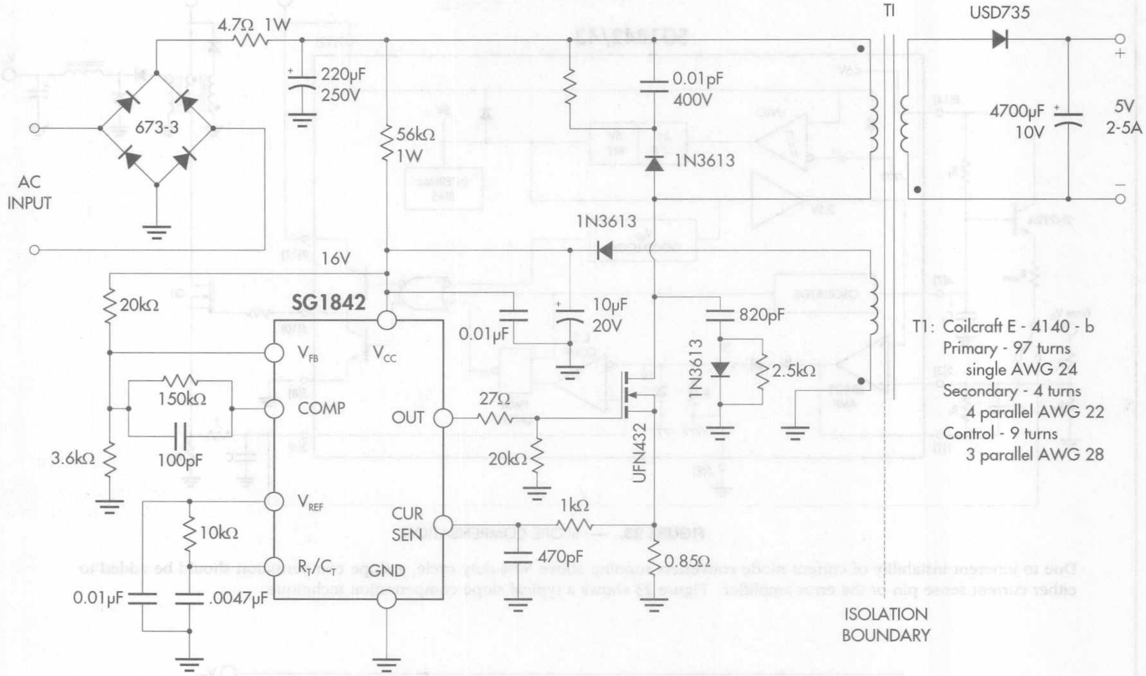


FIGURE 25. — OFF-LINE FLYBACK REGULATOR

SPECIFICATIONS

Input line voltage:	90VAC to 130VAC
Input frequency:	50 or 60Hz
Switching frequency:	40KHz ±10%
Output power:	25W maximum
Output voltage:	5V +5%
Output current:	2 to 5A
Line regulation:	0.01%/V
Load regulation:	8%/A*
Efficiency @ 25 Watts,	
V_{IN} = 90VAC:	70%
V_{IN} = 130VAC:	65%
Output short-circuit current:	2.5Amp average

* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the SG1842 error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.

LIN Doc #: 1844

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1844/SG1845 Series

CURRENT MODE PWM CONTROLLER

PRODUCTION DATA SHEET

DESCRIPTION

The SG1844/45 family of control ICs provides all the necessary features to implement off-line fixed frequency, current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch.

The bandgap reference is trimmed to ±1% over temperature. Oscillator discharge current is trimmed to less than ±10%. The SG1844/45 has under-voltage lockout, current-limiting circuitry and start-up current of less than 1mA.

The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N-channel device.

Both operate up to a maximum duty cycle range of zero to <50% due to an internal toggle flip-flop which blanks the output off every other clock cycle.

The SG1844/45 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2844/45 is specified for the industrial range of -25°C to 85°C, and the SG3844/45 is designed for the commercial range of 0°C to 70°C.

KEY FEATURES

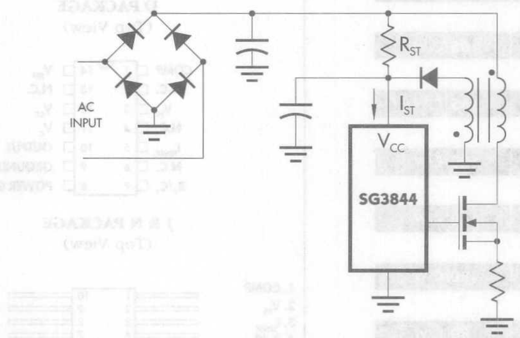
- OPTIMIZED FOR OFF-LINE CONTROL
- LOW START-UP CURRENT (<1mA)
- AUTOMATIC FEED FORWARD COMPENSATION
- TRIMMED OSCILLATOR DISCHARGE CURRENT
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH 6V HYSTERESIS (SG1844 only)
- DOUBLE PULSE SUPPRESSION
- HIGH-CURRENT TOTEM-POLE OUTPUT
- INTERNALLY TRIMMED BANDGAP REFERENCE
- 500kHz OPERATION
- UNDERVOLTAGE LOCKOUT
  SG1844 - 16 volts
  SG1845 - 8.4 volts
- LOW SHOOT-THROUGH CURRENT <75mA OVER TEMPERATURE

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF SG3844 IN A FLYBACK CONVERTER



PACKAGE ORDER INFORMATION

T_A (°C)	M Ceramic DIP 8-pin	N Plastic DIP 14-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	J Ceramic DIP 14-pin	F Cer. Flatpack 10-pin	L Ceramic LCC 20-pin
0 to 70	SG3844M	SG3844N	SG3844DM	SG3844D	SG3844Y	SG3844J	—	—
	SG3845M	SG3845N	SG3845DM	SG3845D	SG3845Y	SG3845J	—	—
-25 to 85	SG2844M	SG2844N	SG2844DM	SG2844D	SG2844Y	SG2844J	—	—
	SG2845M	SG2845N	SG2845DM	SG2845D	SG2845Y	SG2845J	—	—
-55 to 125	—	—	—	—	SG1844Y	SG1844J	—	SG1844L
	—	—	—	—	SG1845Y	SG1845J	—	SG1845L
MIL-STD/883	—	—	—	—	SG1844Y/883B	SG1844J/883B	—	SG1844L/883B
	—	—	—	—	SG1845Y/883B	SG1845J/883B	—	SG1845L/883B
DESC	—	—	—	—	SG1844Y/DESC	SG1844J/DESC	SG1844F/DESC	SG1844L/DESC
			—	—	SG1845Y/DESC	SG1845J/DESC	SG1845F/DESC	SG1845L/DESC

Note: All surface-mount packages are available in Tape & Reel.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG1844/SG1845 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Notes 1 & 2)

Supply Voltage (I_{CC} < 30mA) .... Self Limiting
Supply Voltage (Low Impedance Source) 30V
Output Current (Peak) .... ±1A
Output Current (Continuous) 350mA
Output Energy (Capacitive Load) 5µJ
Analog Inputs (Pins 2, 3) .... -0.3V to +6.3V
Error Amp Output Sink Current 10mA
Operating Junction Temperature
  Hermetic (J, Y, F, L Packages) .... 150°C
  Plastic (N, M, D, DM Packages) .... 150°C
Storage Temperature Range .... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) .... 300°C

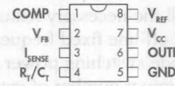
Note 1. Exceeding these ratings could cause damage to the device.
Note 2. All voltages are with respect to Pin 5. All currents are positive into the specified terminal.

THERMAL DATA

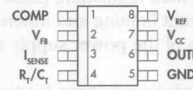
M PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W
DM PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W
D PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W
Y PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W
J PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W
F PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	80°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	145°C/W
L PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

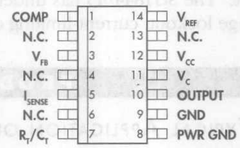
PACKAGE PIN OUTS



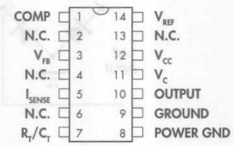
M & Y PACKAGE
(Top View)



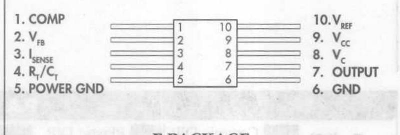
DM PACKAGE
(Top View)



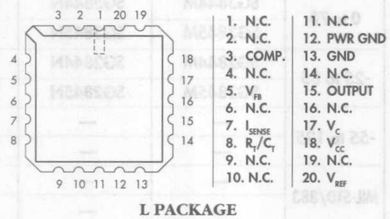
D PACKAGE
(Top View)



J & N PACKAGE
(Top View)



F PACKAGE
(Top View)



L PACKAGE
(Top View)

SG1844/SG1845 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 3)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage Range			30		V
Output Current (Peak)			±1		A
Output Current (Continuous)			200		mA
Analog Inputs (Pin 2, Pin 3)		0		2.6	V
Error Amp Output Sink Current			5		mA
Oscillator Frequency Range		0.1		500	kHz
Oscillator Timing Resistor	R_T	0.52		150	kΩ
Oscillator Timing Capacitor	C_T	0.1		1.0	µF
Operating Ambient Temperature Range:					
SG1844/45		-55		125	°C
SG2844/45		-25		85	°C
SG3844/45		0		70	°C

Note 3. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1844/SG1845 with $-55°C \leq T_A \leq 125°C$, SG2844/SG2845 with $-25°C \leq T_A \leq 85°C$, SG3844/SG3845 with $0°C \leq T_A \leq 70°C$, $V_{CC} = 15V$ (Note 7), $R_T = 10k\Omega$, and $C_T = 3.3nF$. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG1844/45 Min.	Typ.	Max.	SG2844/45 Min.	Typ.	Max.	SG3844/45 Min.	Typ.	Max.	Units
Reference Section												
Output Voltage		$T_J = 25°C$, $I_O = 1mA$	4.95	5.00	5.05	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation		$12 \leq V_{IN} \leq 25V$		6	20		6	20		6	20	mV
Load Regulation		$1 \leq I_O \leq 20mA$		6	25		6	25		6	25	mV
Temperature Stability (Note 4)				0.2	0.4		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation (Note 4)		Line, Load, Temp.	4.90		5.10	4.90		5.10	4.82		5.18	V
Output Noise Voltage (Note 4)	V_N	$10Hz \leq f \leq 10kHz$, $T_J = 25°C$		50			50			50		µV
Long Term Stability (Note 4)		$T_A = 125°C$, 1000hrs		5	25		5	25		5	25	mV
Output Short Circuit			-30	-100	-180	-30	-100	-180	-30	-100	-180	mA
Oscillator Section												
Initial Accuracy (Note 8)		$T_J = 25°C$	47	52	57	47	52	57	47	52	57	kHz
Voltage Stability		$12V \leq V_{CC} \leq 25V$		.02	1		0.2	1		0.2	1	%
Temperature Stability (Note 4)		$T_{MIN} \leq T_A \leq T_{MAX}$		5			5			5		%
Amplitude		$V_{RT/CT}$ (Peak to Peak)		1.7			1.7			1.7		V
Discharge Current		$T_J = 25°C$	7.8	8.3	9.1	7.5	8.4	9.3	7.5	8.4	9.3	mA
		$T_{MIN} \leq T_A \leq T_{MAX}$	6.8		9.3	7.2		9.5	7.2		9.5	mA
Error Amp Section												
Input Voltage		$V_{COMP} = 2.5V$	2.45	2.50	2.55	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current				-0.3	-1		-0.3	1		-0.3	-2	µA
Open Loop Gain	A_{VOL}	$2 \leq V_O \leq 4V$	65	90		65	90		65	90		dB
Unity Gain Bandwidth (Note 4)		$T_J = 25°C$	0.7	1		0.7	1		0.7	1		MHz
Power Supply Rejection Ratio	PSRR	$12 \leq V_{CC} \leq 25V$	60	70		60	70		60	70		dB
Output Sink Current		$V_{VFB} = 2.7V$, $V_{COMP} = 1.1V$	2	6		2	6		2	6		mA
Output Source Current		$V_{VFB} = 2.3V$, $V_{COMP} = 5V$	-0.5	-0.8		-0.5	-0.8		-0.5	-0.8		mA
V_{OUT} High		$V_{VFB} = 2.3V$, $R_L = 15K$ to gnd	5	6		5	6		5	6		V
V_{OUT} Low		$V_{VFB} = 2.7V$, $R_L = 15K$ to V_{REF}		0.7	1.1		0.7	1.1		0.7	1.1	V

(Electrical Characteristics continue next page.)

LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS (Cont'd.)

Parameter	Symbol	Test Conditions	SG1844/45			SG2844/45			SG3844/45			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Current Sense Section												
Gain (Notes 5 & 6)			2.85	3	3.15	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 5)		$V_{COMP} = 5V$	0.9	1	1.1	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 5)	PSRR	$12 \le V_{CC} \le 25V$		70			70			70		dB
Input Bias Current				-2	-10		-2	-10		-2	-10	µA
Delay to Output (Note 4)				150	300		150	300		150	300	ns
Output Section												
Output Low Level		$I_{SINK} = 20mA$		0.1	0.4		0.1	0.4		0.1	0.4	V
		$I_{SINK} = 200mA$		1.5	2.2		1.5	2.2		1.5	2.2	V
Output High Level		$I_{SOURCE} = 20mA$	13	13.5		13	13.5		13	13.5		V
		$I_{SOURCE} = 200mA$	12	13.5		12	13.5		12	13.5		V
Rise Time (Note 4)		$T_J = 25°C, C_L = 1nF$		50	150		50	150		50	150	ns
Fall Time (Note 4)		$T_J = 25°C, C_L = 1nF$		50	150		50	150		50	150	ns
Under-Voltage Lockout Section												
Start Threshold		1844	15	16	17	15	16	17	14.5	16	17.5	V
		1845	7.8	8.4	9.0	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operation Voltage After Turn-On		1844	9	10	11	9	10	11	8.5	10	11.5	V
		1845	7.0	7.6	8.2	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section												
Maximum Duty Cycle			46	48	50	46	48	50	46	48	50	%
Minimum Duty Cycle					0			0			0	%
Power Consumption Section												
Start-Up Current				0.5	1		0.5	1		0.5	1	mA
Operating Supply Current		$V_{FB} = V_{ISENSE} = 0V$		11	17		11	17		11	17	mA
V_{CC} Zener Voltage		$I_{CC} = 25mA$		34			34			34		V

Notes: 4. These parameters, although guaranteed, are not 100% tested in production.

5. Parameter measured at trip point of latch with $V_{VFB} = 0$.

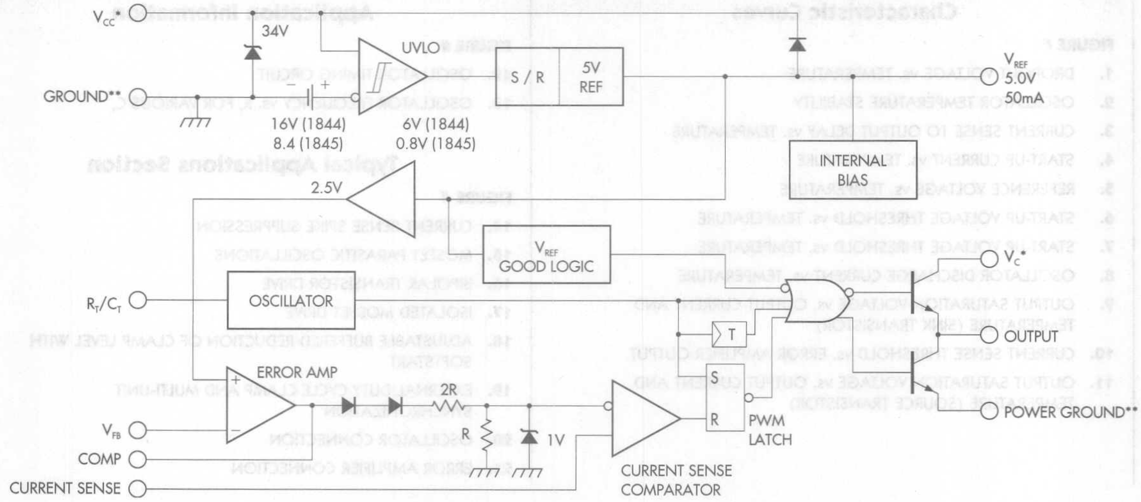
6. Gain defined as: $A = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$; $0 \le V_{ISENSE} \le 0.8V$.

7. Adjust V_{CC} above the start threshold before setting at 15V.

8. Output frequency equals one half of oscillator frequency.

LINFINITY MICROELECTRONICS

BLOCK DIAGRAM



* - V_{CC} and V_C are internally connected for 8-pin packages.
** - POWER GROUND and GROUND are internally connected for 8-pin packages.

SG1844/SG1845 Series

CURRENT-MODE PWM CONTROLLER

PRODUCTION DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Information

Typical Applications Section

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — DROPOUT VOLTAGE vs. TEMPERATURE

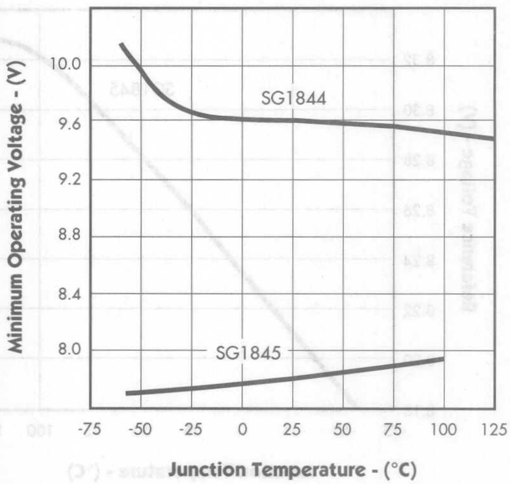


FIGURE 2. — OSCILLATOR TEMPERATURE STABILITY

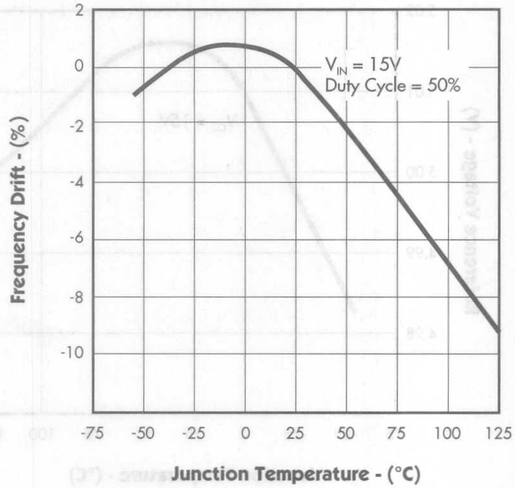


FIGURE 3. — CURRENT SENSE TO OUTPUT DELAY vs. TEMPERATURE

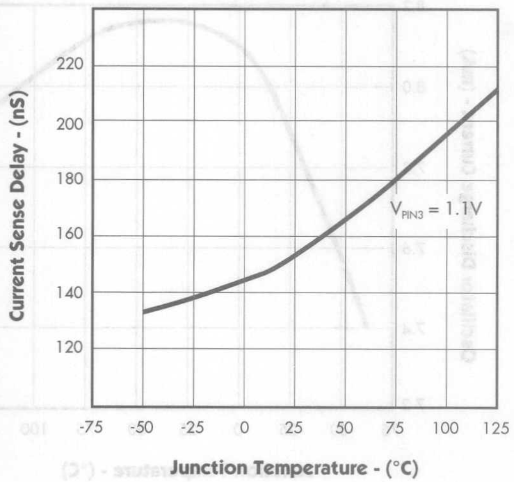
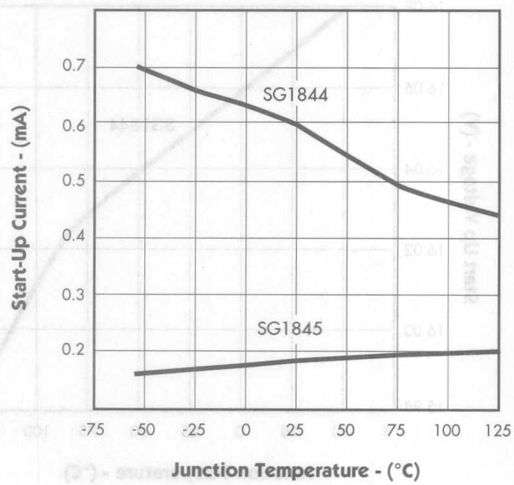


FIGURE 4. — START-UP CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — REFERENCE VOLTAGE vs. TEMPERATURE

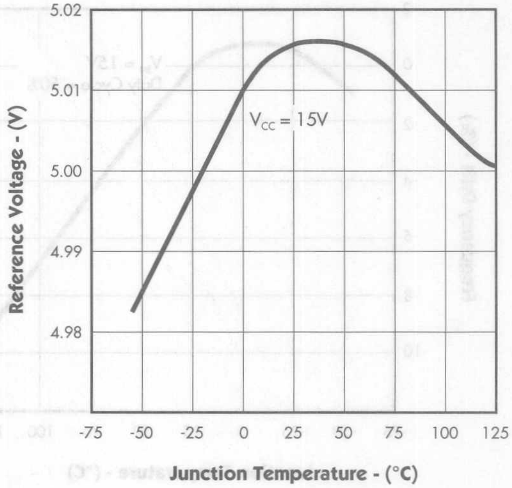


FIGURE 6. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE

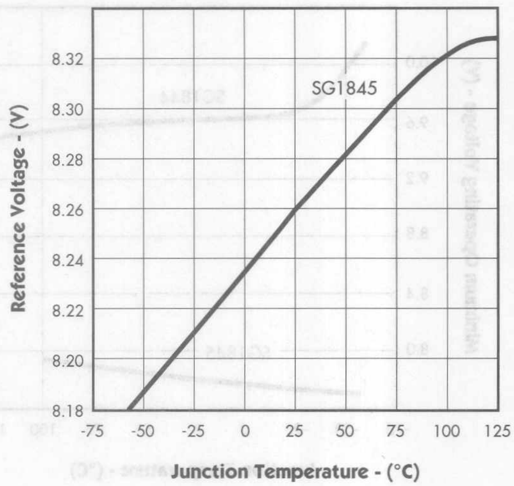


FIGURE 7. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE

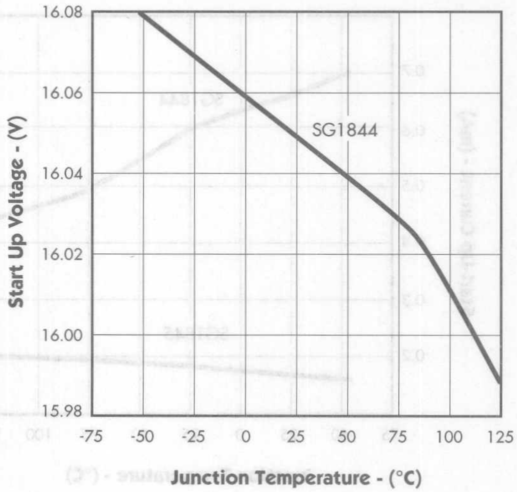
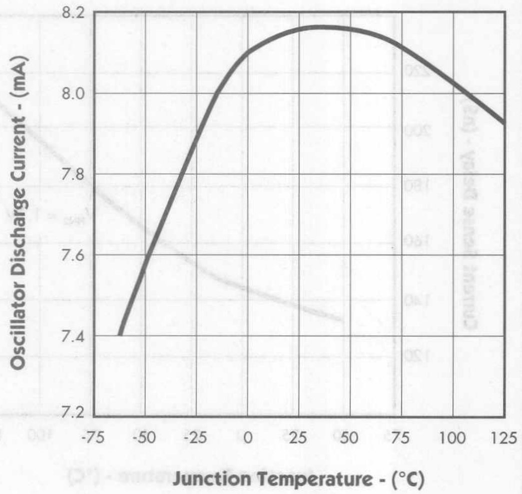


FIGURE 8. — OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 9. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE

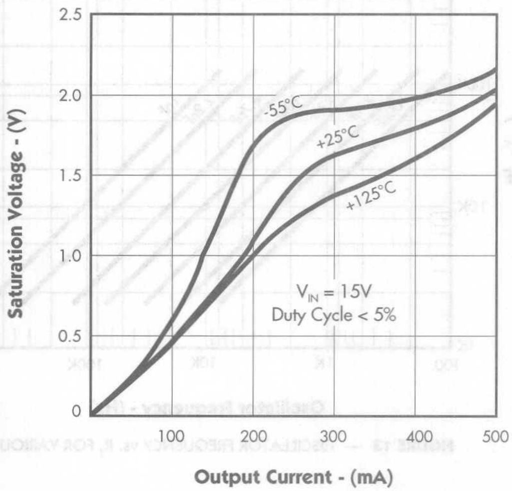


FIGURE 10. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT

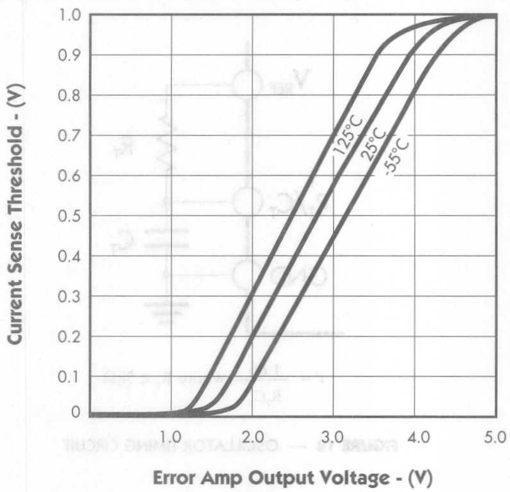
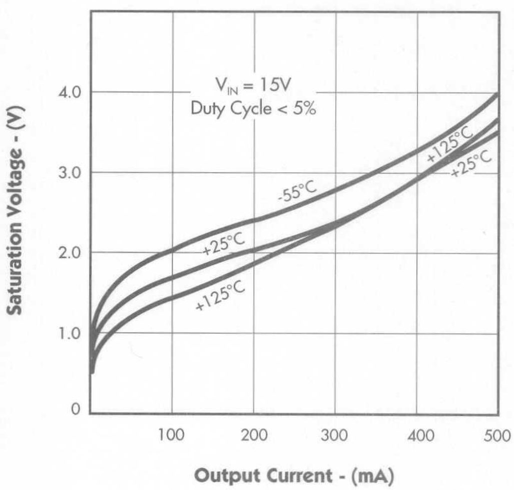


FIGURE 11. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE

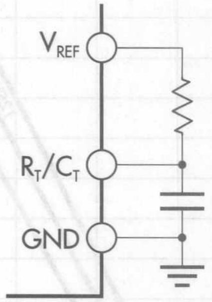


LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

OSCILLATOR

The oscillator of the 1844/45 family of PWM's is programmed by the external timing components (RT, CT) as shown in Figure 13.



$F \approx \frac{1.86}{R_T C_T}$ where $R_T \geq 5k\Omega$

FIGURE 12 — OSCILLATOR TIMING CIRCUIT

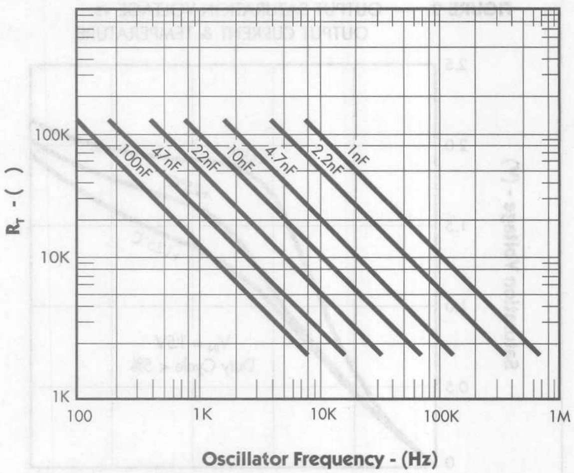


FIGURE 13 — OSCILLATOR FREQUENCY vs. R_T FOR VARIOUS C_T

TYPICAL APPLICATION CIRCUITS

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.

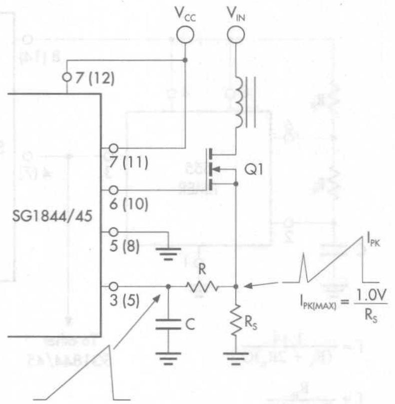


FIGURE 14. — CURRENT SENSE SPIKE SUPPRESSION

The RC low-pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

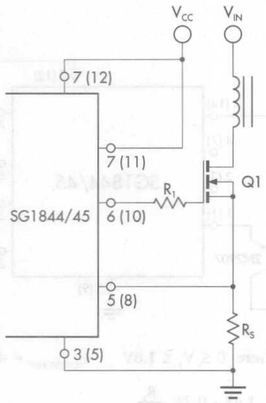


FIGURE 15. — MOSFET PARASITIC OSCILLATIONS

A resistor (R_1) in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

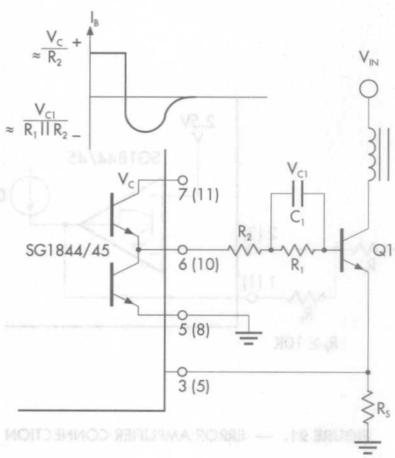
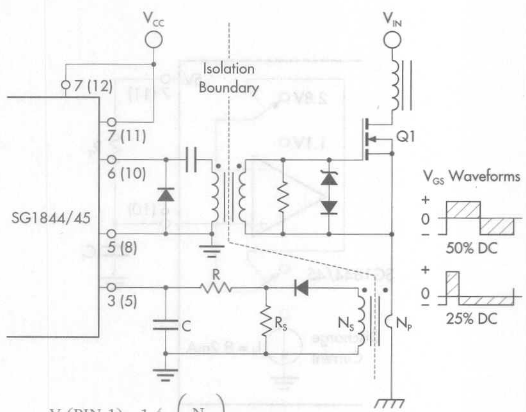


FIGURE 16. — BIPOLAR TRANSISTOR DRIVE

The 1844/45 output stage can provide negative base current to remove base charge of power transistor (Q_1) for faster turn off. This is accomplished by adding a capacitor (C_1) in parallel with a resistor (R_1). The resistor (R_1) is to limit the base current during turn on.

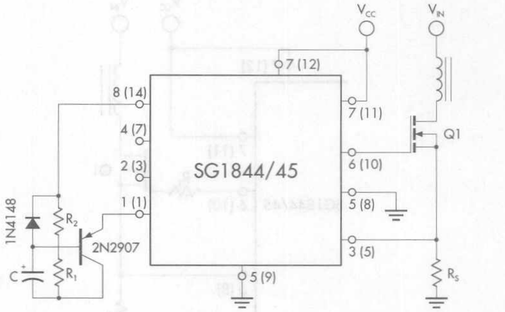


$$I_{PK} = \frac{V\,(\text{PIN }1) - 1.4}{3R_S}\left(\frac{N_P}{N_S}\right)$$

FIGURE 17. — ISOLATED MOSFET DRIVE

Current transformers can be used where isolation is required between PWM and Primary ground. A drive transformer is then necessary to interface the PWM output with the MOSFET.

TYPICAL APPLICATION CIRCUITS (continued)

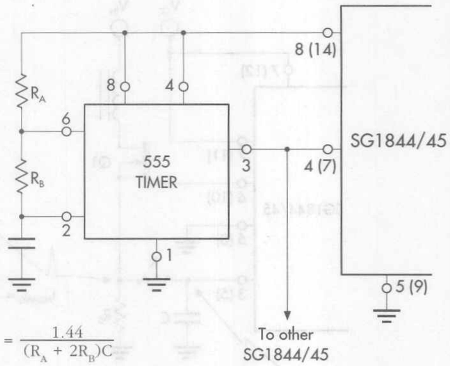


$I_{PK} = \frac{V_1}{R_S}$ Where: $0 \le V_1 \le 1.0V$ $\quad t_{SOFTSTART} = -\ln\left[1 - \frac{V_C}{V_2}\right] C \frac{R_1 R_2}{R_1+R_2}$

and $V_1 = \frac{1.43 - 0.23\frac{R_1}{R_2}}{1+\frac{R_1}{R_2}}$ $\quad$ where: $V_2 = \frac{0.5}{1+\frac{R_1}{R_2}}$

FIGURE 18. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART

Softstart and adjustable peak current can be done with the external circuitry shown above.



$$f = \frac{1.44}{(R_A + 2R_B)C}$$

$$f = \frac{R_B}{R_A + 2R_B}$$

FIGURE 19. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION

Precision duty cycle limiting for a duty cycle of <50%, as well as synchronizing several 1844/45's is possible with the above circuitry.

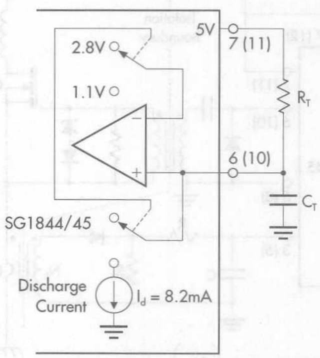


FIGURE 20. — OSCILLATOR CONNECTION

The oscillator is programmed by the values selected for the timing components R_T and C_T. Refer to application information for calculation of the component values.

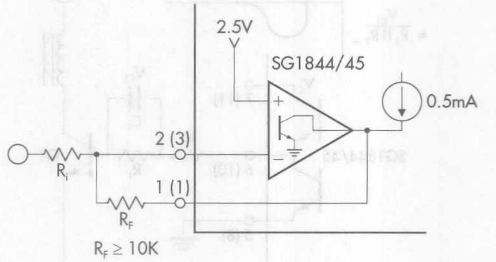


FIGURE 21. — ERROR AMPLIFIER CONNECTION

Error amplifier is capable of sourcing and sinking current up to 0.5mA.

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1846/SG2846/SG3846

CURRENT MODE PWM CONTROLLER

PRODUCTION DATA SHEET

DESCRIPTION

The SG1846 family of control ICs provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to parallel "power modules" while maintaining equal current sharing.

Protection circuitry includes built-in under-voltage lockout and programmable current limit in addition to soft start capability. A shutdown function is also available which can initiate either a complete shutdown with automatic restart or latch the supply off.

Other features include fully latched operation, double pulse suppression, deadtime adjust capability, and a ±1% trimmed bandgap reference.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

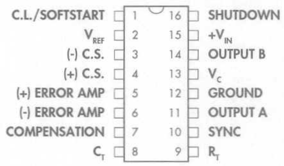
KEY FEATURES

- AUTO-FEED FORWARD COMPENSATION
- PROGRAMMABLE PULSE BY PULSE CURRENT LIMITING
- AUTOMATIC SYMMETRY CORRECTION IN PUSH-PULL CONFIGURATION
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- PARALLEL OPERATION CAPABILITY FOR MODULAR POWER SYSTEMS
- DIFFERENTIAL CURRENT SENSE AMPLIFIER WITH WIDE COMMON MODE RANGE
- DOUBLE PULSE SUPPRESSION
- 200mA TOTEM-POLE OUTPUTS
- ±1% BANDGAP REFERENCE
- UNDER-VOLTAGE LOCKOUT
- SOFT-START & SHUTDOWN CAPABILITY
- 500kHz OPERATION

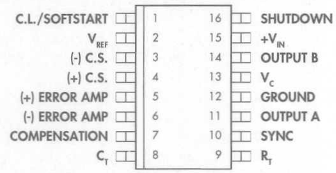
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

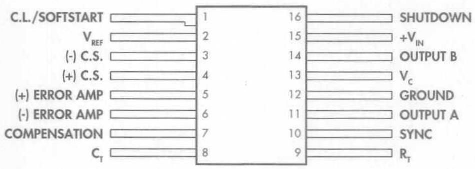
PACKAGE PIN OUTS



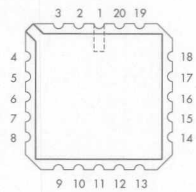
J & N PACKAGE
(Top View)



DW PACKAGE
(Top View)



F PACKAGE
(Top View)



1. N.C.	11. N.C.
2. C.L./SOFTSTART	12. R_T
3. V_{REF}	13. SYNC
4. (-) C.S.	14. OUTPUT A
5. (+) C.S.	15. GROUND
6. N.C.	16. N.C.
7. (+) ERROR AMP	17. V_C
8. (-) ERROR AMP	18. OUTPUT B
9. COMPENSATION	19. V_{IN}
10. C_T	20. SHUTDOWN

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	F Ceramic Flat Pack 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3846N	SG3846J	SG3846DW	—	—
-25 to 85	SG2846N	SG2846J	SG2846DW	—	—
-55 to 125	—	SG1846J	—	—	SG1846L
MIL-STD-883	—	SG1846J/883B	—	—	SG1846L/883B
DESC	—	SG1846J/DESC	—	SG1846F/DESC	SG1846L/DESC

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3846DWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

SG29055/SG29055A

LOW DROPOUT DUAL REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG29055/SG29055A is a dual 5V/ 5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output, but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29055/SG29055A well suited for power systems that require standby memory. The SG29055/SG29055A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

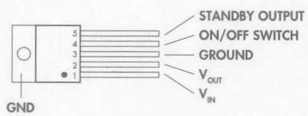
The SG29055 is the 5 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 8.2V and 12V are available. Also available is the SG29055A which offers an improved output voltage tolerance of ±2%. They are available in the plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT OUTPUT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



P PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	P Plastic TO-220 5-pin
-45 to 85	SG29055P
	SG29055AP

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG29085/SG29085A

LOW DROPOUT DUAL REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG29085/SG29085A is a dual 8.2V/5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29085/SG29085A well suited for power systems that require standby memory. The SG29085/SG29085A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

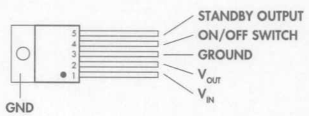
The SG29085 is the 8.2 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 5 and 12 volts are available. Also available is the SG28085A which offers an improved output voltage tolerance of ±2%. They are available in the plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT OUTPUT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



P PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	P Plastic TO-220 5-pin
-45 to 85	SG29085P
	SG29085AP

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG29125/SG29125A

LOW DROPOUT DUAL REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG29125/SG29125A is a dual 12V/5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29125/SG29125A well suited for power systems that require standby memory. The SG29125/SG29125A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

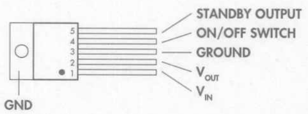
The SG29125 is the 12 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 5 and 8.2 volts are available. Also available is the SG29125A which offers an improved output voltage tolerance of ±2%. They are available in the Plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT OUTPUT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



P PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	P Plastic TO-220 5-pin
-45 to 85	SG29125P
	SG29125AP

LINFINITY
MICROELECTRONICS

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THE INFINITE POWER OF INNOVATION

SG33164/SG34164

5V Undervoltage Sensing Circuit

Production Data Sheet

DESCRIPTION

The SG33164 and the SG34164 are micropower undervoltage sensing circuits ideal for use in low-power battery applications, computer peripheral, consumer, appliance and automotive equipment. The device offers a 1.2V temperature compensated bandgap reference, a precision comparator with hysteresis and a high current open collector output. This device operates from 1 to 10V input supply and drains <10µA in the non-fault condition and trip level of 4.33V.

Both devices are available in an 8-pin, 150mil SOIC package and a plastic TO-92 package. The SG33164 is rated from -40°C to 85°C and the SG34164 from 0°C to 70°C.

KEY FEATURES

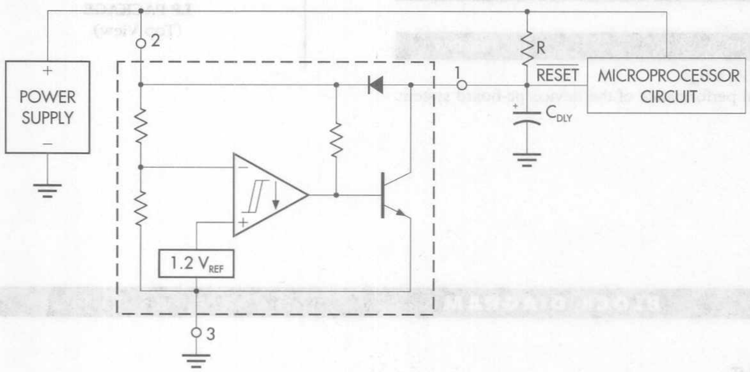
- LOW STANDBY CURRENT
- TEMPERATURE COMPENSATED BANDGAP REFERENCE
- PRECISION COMPARATOR WITH 50MV OF HYSTERESIS
- CLAMP DIODE FOR DISCHARGING DELAY CAPACITOR
- OUTPUT CURRENT SINK CAPABILITY FROM 7 TO 50MA
- 1-10V INPUT SUPPLY RANGE
- AVAILABLE IN 150MIL, 8-PIN SOIC AND PLASTIC TO-92 PACKAGES
- PIN-FOR-PIN COMPATIBLE WITH MC33164/34164

APPLICATIONS

- µPOWER RESET GENERATOR
- 5V VOLTAGE MONITOR
- BATTERY-LEVEL DETECTOR

PRODUCT HIGHLIGHT

Low-Voltage Microprocessor Reset



PACKAGE ORDER INFORMATION

T_A (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	SG34164DM	SG34164LP
-40 to 85	SG33164DM	SG33164LP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG34164DMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 Western Avenue, Garden Grove, CA. 92841

SG33164/SG34164

5V Undervoltage Sensing Circuit

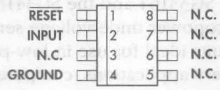
Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

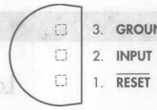
Input Supply Voltage (V_{IN}) .... -1V to 12V
RESET Output Voltage (V_{OUT}) .... -1V to 12V
Clamp Diode Forward Current 100mA
Operating Junction Temperature
Plastic (DM - Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

THERMAL DATA

DM PACKAGE:

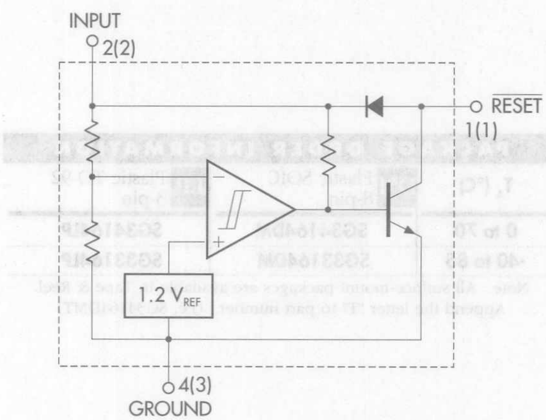
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM



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MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Supply Voltage		1		10	V
$\overline{\text{RESET}}$ Output Voltage				10	V
Clamp Diode Forward Current				50	mA
Operating Ambient Temperature Range:					
SG34164	T_A	0		70	°C
SG33164	T_A	-40		85	°C

Note 2. Range over which the device is guaranteed functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C for the SG34164 and -40°C ≤ T_A ≤ 85°C for the SG33164. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG33164 / SG34164 Min.	Typ.	Max.	Units
Total Device						
Operating Input Voltage Range	V_{IN}		1.0		10	V
Quiescent Input Current	I_{IN}	V_{IN} = 5.0V		10	20	µA
		V_{IN} = 10V		19	50	µA
Comparator Section						
Threshold Voltage						
High-State Output	V_{IH}	V_{IN} Increasing	4.15	4.33	4.45	V
Low-State Output	V_{IL}	V_{IN} Decreasing	4.15	4.27	4.45	V
Hysteresis	V_H		0.02	0.06		V
$\overline{\text{RESET}}$ Output Section						
Output Sink Saturation	V_{OL}	V_{IN} = 4.0V, I_{SINK} = 1.0mA		0.05	0.40	V
		V_{IN} = 1.0V, I_{SINK} = 0.25mA		0.06	0.30	V
Output Sink Current	I_{SINK}	V_{IN}, $\overline{\text{RESET}}$ = 4.0V	7.0		50	mA
Output Off-State Leakage		V_{IN}, $\overline{\text{RESET}}$ = 5.0V			0.5	µA
		V_{IN}, $\overline{\text{RESET}}$ = 10V			2.0	µA
Clamp Diode Forward Voltage	V_F	Pin 1 to pin 2, (I_F = 5.0mA)	0.6		1.2	V

SG33164/SG34164

5V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Circuits

CHARACTERISTIC CURVES

FIGURE 1. — COMPARATOR THRESHOLD VOLTAGE vs. TEMPERATURE

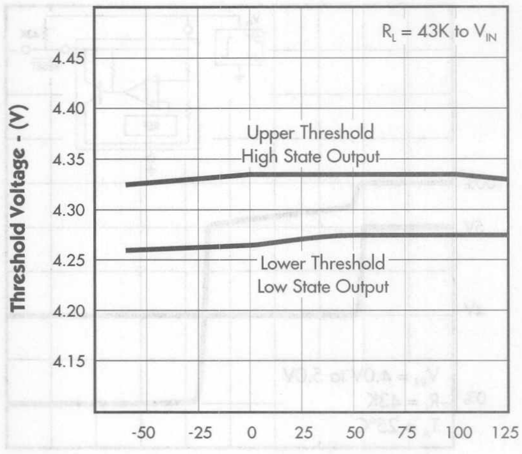


FIGURE 2. — $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. INPUT VOLTAGE

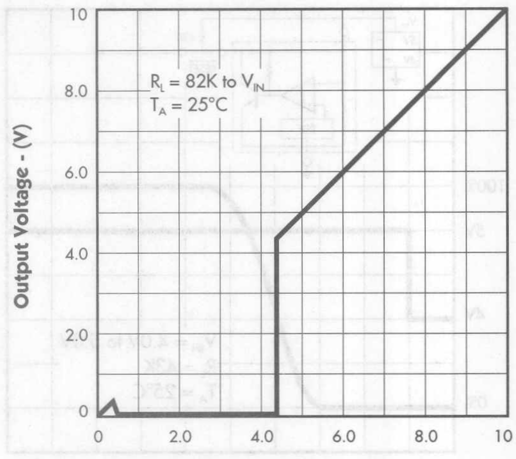


FIGURE 3. — $\overline{\text{RESET}}$ OUTPUT SATURATION vs. SINK CURRENT

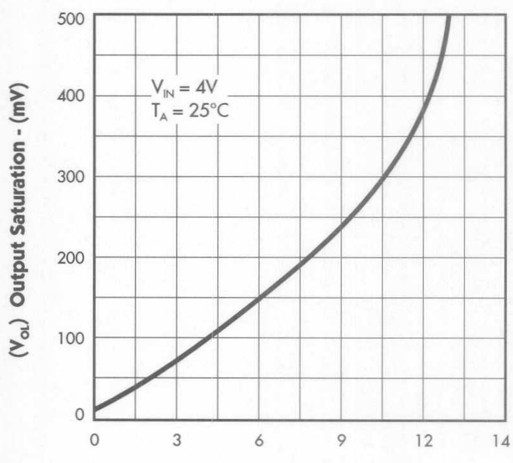
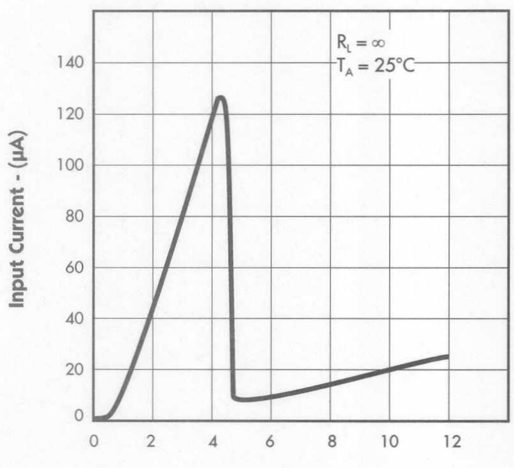
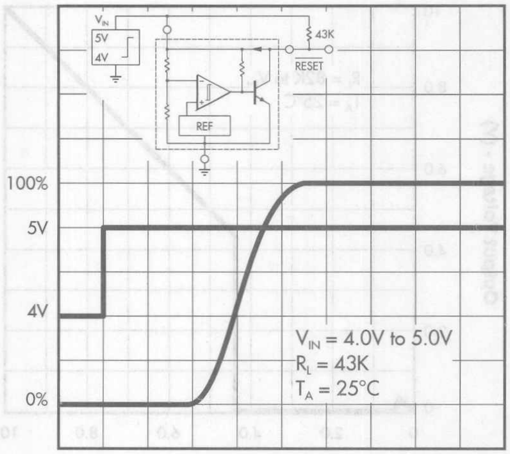


FIGURE 4. — INPUT CURRENT vs. INPUT VOLTAGE



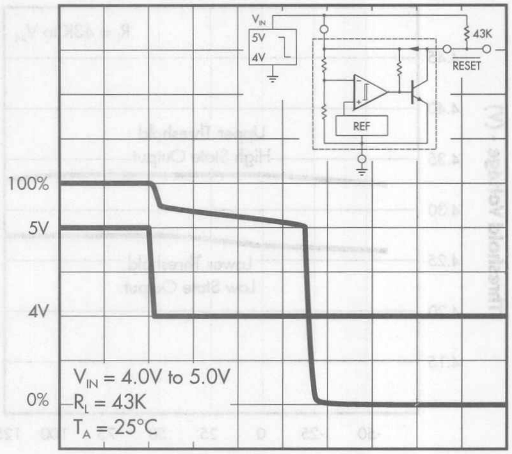
CHARACTERISTIC CURVES

FIGURE 5. — RESET DELAY TIME (LOW TO HIGH)



2µs/DIV.

FIGURE 6. — RESET DELAY TIME (HIGH TO LOW)



0.5µs/DIV.

TYPICAL APPLICATION CIRCUITS

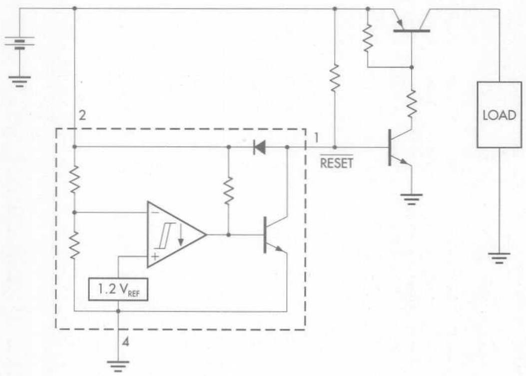
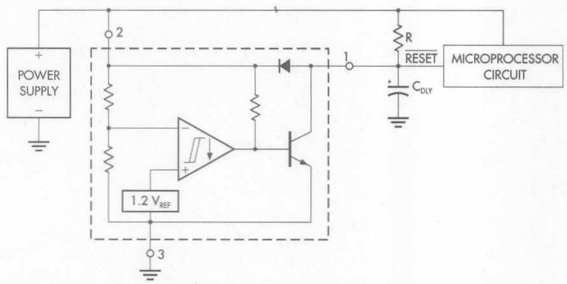


FIGURE 7. — SWITCHING THE LOAD OFF WHEN BATTERY VOLTAGE REACHES BELOW 4.3V



A time delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC_{DLY} time constant be greater than 5.0µs. $V_{TH(MPU)}$ is the microprocessor reset input threshold.

$$t_{DLY} = R\,C_{DLY} \ln\left[\frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}}\right]$$

FIGURE 8. — LOW-VOLTAGE MICROPROCESSOR RESET

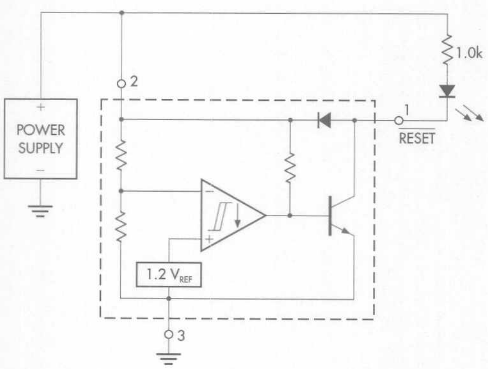
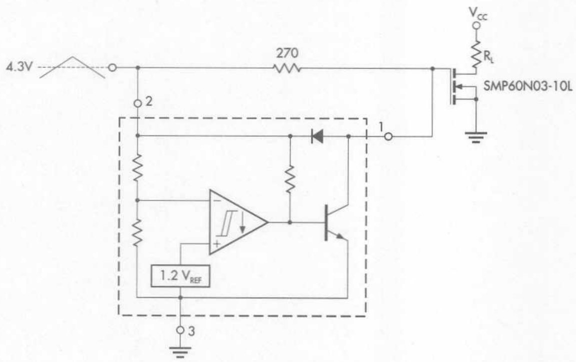


FIGURE 9. — VOLTAGE MONITOR



Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.3 volt threshold of the SG34164, its output grounds the gate of the L² MOSFET.

FIGURE 10. — MOSFET LOW-VOLTAGE GATE DRIVE PROTECTION

Notes

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SG3546

3.3V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

DESCRIPTION

The SG3546 is an undervoltage sensing circuit specifically designed for use as a reset controller in 3.3V microprocessor-based applications. Its micropower operation makes this device ideal for portable applications where extended battery life is required. The device offers a 1.2V temperature compensated bandgap reference, a precision comparator with hysteresis and a high-current open collector output. This device operates from 1 to 10V input supply and drains <10µA in the non-fault condition.

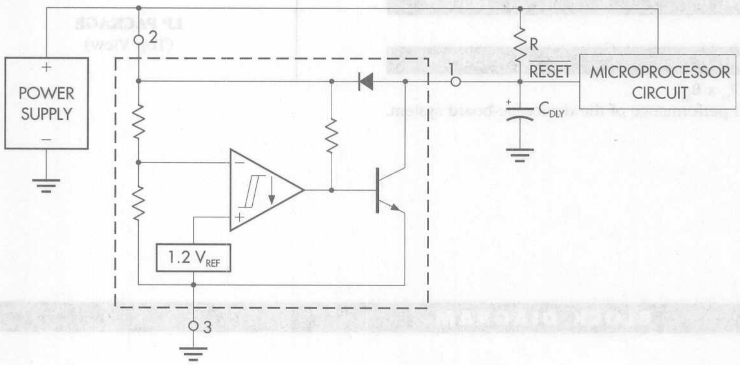
The SG3546 is available in an 8-pin 150mil SOIC package or a 3-pin TO-92 package and is rated for an ambient temperature of 0°C to 70°C.

KEY FEATURES

- LOW STANDBY CURRENT
- INTERNAL VOLTAGE THRESHOLD AT 2.95V
- TEMPERATURE COMPENSATED BANDGAP REFERENCE
- PRECISION COMPARATOR WITH 40MV OF HYSTERESIS
- CLAMP DIODE FOR DISCHARGING DELAY CAPACITOR
- OUTPUT CURRENT SINK CAPABILITY (typ 5mA)
- 1-10V INPUT SUPPLY RANGE
- AVAILABLE IN 150MIL, 8-PIN SOIC AND 3-PIN TO-92 PACKAGES

PRODUCT HIGHLIGHT

Low-Voltage Microprocessor Reset



PACKAGE ORDER INFORMATION

T_A (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	SG3546DM	SG3546LP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3546DMT)

SG3546

3.3V Undervoltage Sensing Circuit

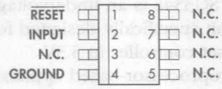
Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

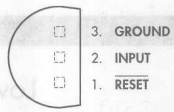
Input Supply Voltage (V_{IN}) .... -1V to 12V
RESET Output Voltage (V_{OUT}) .... -1V to 12V
Clamp Diode Forward Current 100mA
Operating Junction Temperature
  Plastic (DM - Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

THERMAL DATA

DM PACKAGE:

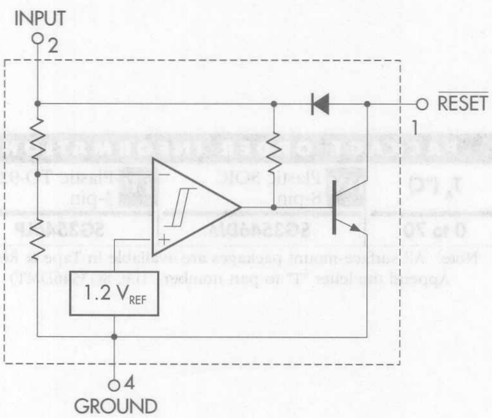
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM



LinFinity
MICROELECTRONICS

3.3V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Input Supply Voltage		1		10	V
RESET Output Voltage				10	V
Clamp Diode Forward Current				50	mA
Operating Ambient Temperature Range:					
SG3546	T_A	0		70	°C

Note 2. Range over which the device is guaranteed functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C for the SG3546. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG3546 Min.	Typ.	Max.	Units
Total Device						
Operating Input Voltage Range	V_{IN}		1.0		10	V
Quiescent Input Current	I_{IN}	V_{IN} = 3.3V		10	20	µA
		V_{IN} = 10V		19	50	µA
Comparator Section						
Threshold Voltage						
High-State Output	V_{IH}	V_{IN} Increasing	2.75	2.81	3.0	V
Low-State Output	V_{IL}	V_{IN} Decreasing	2.75	2.86	3.0	V
Hysteresis	V_H			40		mV
$\overline{\text{RESET}}$ Output Section						
Output Sink Saturation	V_{OL}	V_{IN} = 2.6V, I_{SINK} = 1mA		0.05	0.40	V
		V_{IN} = 1.0V, I_{SINK} = 100µA		0.06	0.30	V
Output Sink Current	I_{SINK}	V_{IN}, $\overline{\text{RESET}}$ = 2.6V			20	mA
Output Off-State Leakage		V_{IN}, $\overline{\text{RESET}}$ = 3.6V			0.5	µA
		V_{IN}, $\overline{\text{RESET}}$ = 10V			2.0	µA
Clamp Diode Forward Voltage	V_F	Pin 1 to pin 2, (I_F = 5.0mA)	0.5		1.2	V

LINFINITY MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Circuits

LINFINITY MICROELECTRONICS

3.3V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

CHARACTERISTIC CURVES

FIGURE 1. — COMPARATOR THRESHOLD VOLTAGE vs. TEMPERATURE

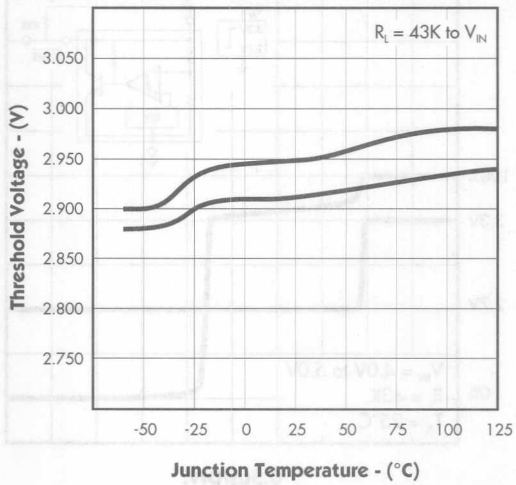


FIGURE 2. — $\overline{\text{RESET}}$ OUTPUT VOLTAGE vs. INPUT VOLTAGE

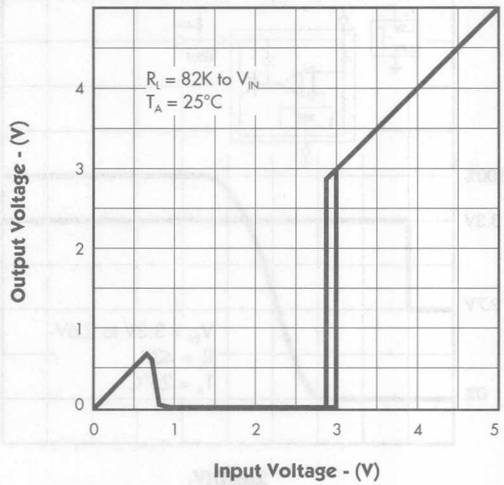


FIGURE 3. — $\overline{\text{RESET}}$ OUTPUT SATURATION vs. SINK CURRENT

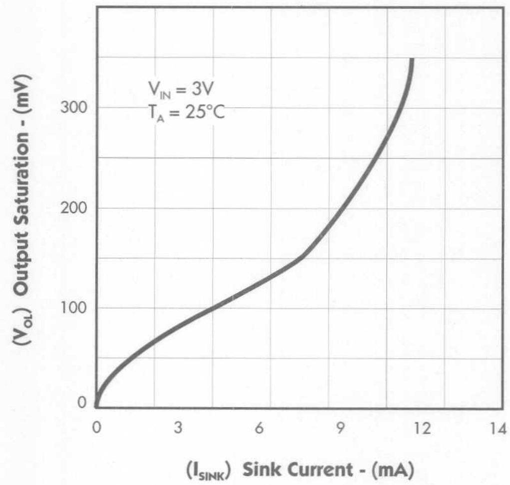
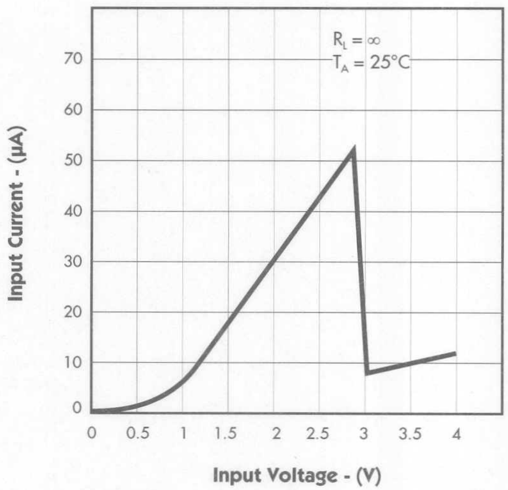
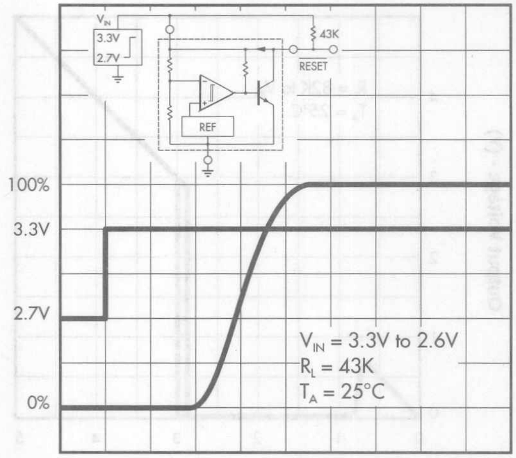


FIGURE 4. — INPUT CURRENT vs. INPUT VOLTAGE



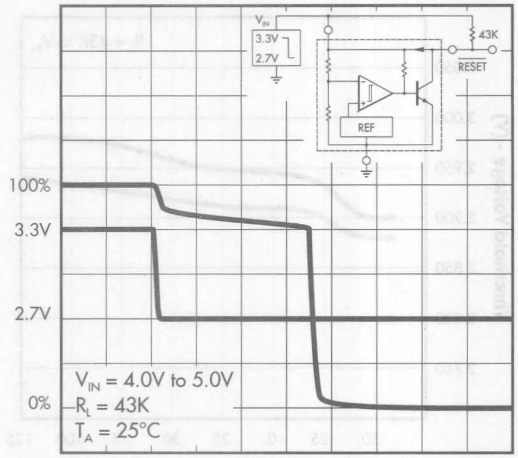
CHARACTERISTIC CURVES

FIGURE 5. — $\overline{\text{RESET}}$ DELAY TIME (LOW TO HIGH)



2µs/DIV.

FIGURE 6. — $\overline{\text{RESET}}$ DELAY TIME (HIGH TO LOW)



0.5µs/DIV.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS

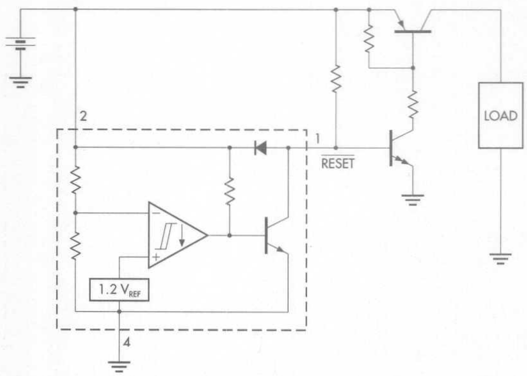
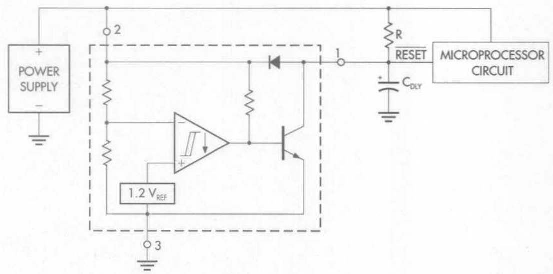


FIGURE 7. — SWITCHING THE LOAD OFF WHEN BATTERY VOLTAGE REACHES BELOW V_{TH}



A time-delayed reset can be accomplished with the addition of C_{DLY}. For systems with extremely fast power supply rise times (< 500ns), it is recommended that the RC_{DLY} time constant be greater than 5.0µs. $V_{TH(MPU)}$ is the microprocessor reset input threshold.

$$t_{DLY} = R\,C_{DLY} \ln \left[\frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}} \right]$$

FIGURE 8. — LOW VOLTAGE MICROPROCESSOR RESET

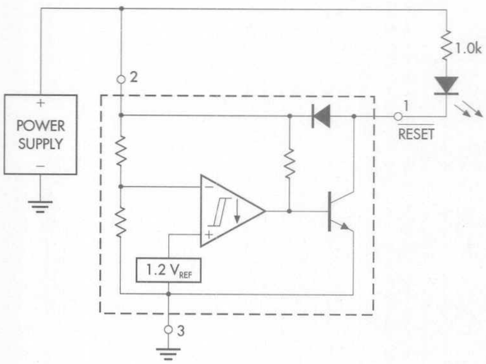


FIGURE 9. — VOLTAGE MONITOR

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG3561A

POWER FACTOR CONTROLLER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

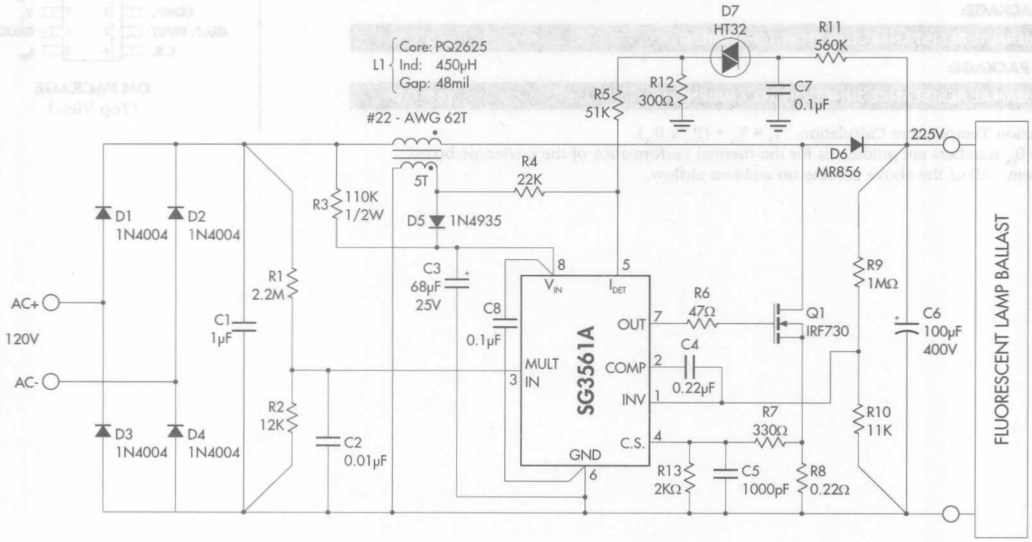
This monolithic integrated circuit provides all the necessary functions for designing an active power factor correction circuit in conjunction with off-line power converters. Although the IC is optimized for electronic ballast applications, it can also be used in switched mode AC-DC power converters. Included in the 8-pin DIP package are; an under voltage lockout with a micropower start-up with a 2V hysteresis, an internal temperature compensated bandgap reference, a unity gain stable error amplifier, one quadrant multiplier stage, a current sense comparator and a totem pole output stage for directing driving of the power MOSFET. In addition to the above, an internal logic circuit detects the zero crossing of the inductor current and maintains discontinuous current mode of operation such that it allows no current gaps to appear. This type of operation provides a higher P.F. correction, as well as lower harmonic distortion over the fixed frequency discontinuous current mode. The SG3561A is characterized for operation over the ambient temperature range of -25°C to +85°C.

KEY FEATURES

- MICRO-POWER START-UP MODE (250µA typ.)
- LOW OPERATING CURRENT CONSUMPTION
- INTERNAL 1.5% REFERENCE
- TOTEM POLE OUTPUT STAGE
- AUTOMATIC CURRENT LIMITING OF BOOST STAGE
- DISCONTINUOUS MODE OF OPERATION WITH NO CURRENT GAPS
- NO SLOPE COMPENSATION REQUIRED
- AVAILABLE IN 8 & 14-PIN PLASTIC DIP AND 8-PIN SOIC PACKAGE
- **SEE LX1562/1563 FOR NEW DESIGNS**

PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL



PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	N Plastic DIP 14-pin	DM Plastic SOIC 8-pin
-25 to 85	SG3561AM	SG3561AN	SG3561ADM

Note: All surface mount packages are available in Tape & Reel. Append the letter "T" to part number (i.e. SG3561ADMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG3561A

POWER FACTOR CONTROLLER

NOT RECOMMENDED FOR NEW DESIGNS

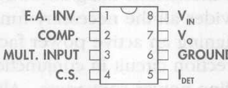
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (V_{IN})	-0.3V to 28V
Peak Driver Output Current	±500mA
Driver Output Clamping Diodes	
$V_Q > V_{CC}$ or $V_Q < -0.3V$	±10mA
Detector Clamping Diodes	
$V_{DET} > 6V$ or $V_{DET} < 0.9V$	±10mA
Error Amp, Multiplier, and Comparator Input Voltages	-0.3V to 6V
Detector Input Voltage (Note 2)	0.95 to 6V
Operating Junction Temperature	
Plastic (M, N and DM Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 Seconds)	300°C

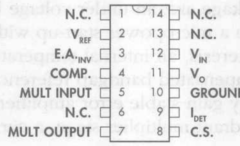
Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

Note 2. With no limiting resistor.

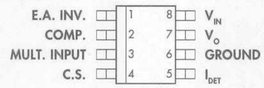
PACKAGE PIN OUTS



M PACKAGE
(Top View)



N PACKAGE
(Top View)



DM PACKAGE
(Top View)

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

LINFINITY MICROELECTRONICS

POWER FACTOR CONTROLLER

NOT RECOMMENDED FOR NEW DESIGNS

RECOMMENDED OPERATING CONDITIONS (Note 3)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage Range	V_{IN}	11		25	V
Peak Driver Output Current			±300		mA
Operating Ambient Temperature Range:					
SG3561A	T_A	-25		85	°C

Note 3. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the SG3561A with -25°C ≤ T_A ≤ +85°C; V_{IN}=12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG3561A Min.	Typ.	Max.	Units
Under-Voltage Lockout Section						
Start Threshold Voltage			9.2	10	10.8	V
UV Lockout Hysteresis			1.6	2.0	2.4	V
Supply Current Section						
Start-Up Supply Current		$V_{IN} < V_{TH}$		0.25	0.5	mA
Operating Supply Current		V_{IN} = 12V, Output Not Switching		6	12	mA
Dynamic Operating Supply Current	AVE	V_{IN} = 12V, 50KHz, CGS = 1000pF		10	15	mA
Reference Section (Note 4)						
Initial Accuracy		I_{REF} = 0mA, T_J = 25°C	2.463	2.50	2.538	V
Line Regulation		12V < V_{IN} < 25V		0.1	10	mV
Load Regulation		0 < I_{REF} < 2mA		0.1	10	mV
Temperature Stability				20		mV
Error Amplifier Section						
Input Offset Voltage (Note 4)			-15		15	mV
Input Bias Current			-2	-0.1		µA
Large Signal Open Loop Voltage Gain		(Note 4)	60	86		dB
Slew Rate				0.6		v/µsec
Power Supply Rejection Ratio (Note 4)			60	86		dB
Output Source Current		V_{OH} = 3.5V	2			mA
Output Sink Current		V_{OL} = 2.0V	2			mA
Output Voltage Range (Note 6)		No Load on E.A. Output	1.2		4	V
Unity Gain Bandwidth				1.0		MHz
Phase Margin				57		°

(Electrical Characteristics continued next page.)

LINFINITY MICROELECTRONICS

NOT RECOMMENDED FOR NEW DESIGNS

ELECTRICAL CHARACTERISTICS (Cont'd.)

Parameter	Symbol	Test Conditions	SG3561A Min.	SG3561A Typ.	SG3561A Max.	Units
Multiplier Section						
M1 Input Voltage Range			0		2	V
M2 Input Voltage Range			V_{REF}		$V_{REF}+1$	V
Input Bias Current (M1)			-2		2	µA
Multiplier Gain (Note 5), (Note 4)		$V_{M1} = 1V$, $V_{EA0} = 3.5V$	0.52	0.65	0.78	/V
		$V_{M1} = 2V$, $V_{EA0} = 3.5V$		0.65		/V
Multiplier Gain Temperature Stability				-0.2		%/°C
Maximum Multiplier Output Voltage		$V_{M1} = 1V$, $V_{EA0} > 4V$		0.9		V
		$V_{M1} = 2V$, $V_{EA0} > 4V$		1.8		V
Current Sense Comparator Section						
Input Bias Current		$0V \le V_{CS} \le 1.7V$	-5	1	5	µA
Current Sense Delay to Output		$E.A._{OUT} = 3.7V$		200	500	ns
Detect Section						
Input Voltage Threshold			1	1.3	1.6	V
Hysteresis				175		mV
Input LO Clamp Voltage		$I_{DET} = 100µA$			0.95	V
Input HI Clamp Voltage		$I_{DET} = 3mA$	6.1	7.1		V
Input Current		$1V \le V_{DET} \le 6V$	-10		10	µA
Input HI/LO Clamp Diode Current		$V_{DET} < 0.9V$, $V_{DET} > 6V$			±3	mA
Output Driver Section						
Output High Voltage		$I_L = -10mA$, $V_{IN} = 12V$	7	9		V
Output Low Voltage		$I_L = 10mA$, $V_{IN} = 12V$		0.8	1.5	V
Output Rise Time		$C_L = 1000pF$		100	200	ns
Output Fall Time		$C_L = 1000pF$		90	200	ns

Notes: 4. Because the reference is not brought out externally, these specifications are tested at probe only, and cannot be tested on the packaged part. They are guaranteed by design, and shown for illustrative purposes only.

5. $K = \frac{V_{MO}}{(V_{M1}) \times (V_{EA0} - V_{REF})}$

6. This parameter, although guaranteed, is not tested in production.

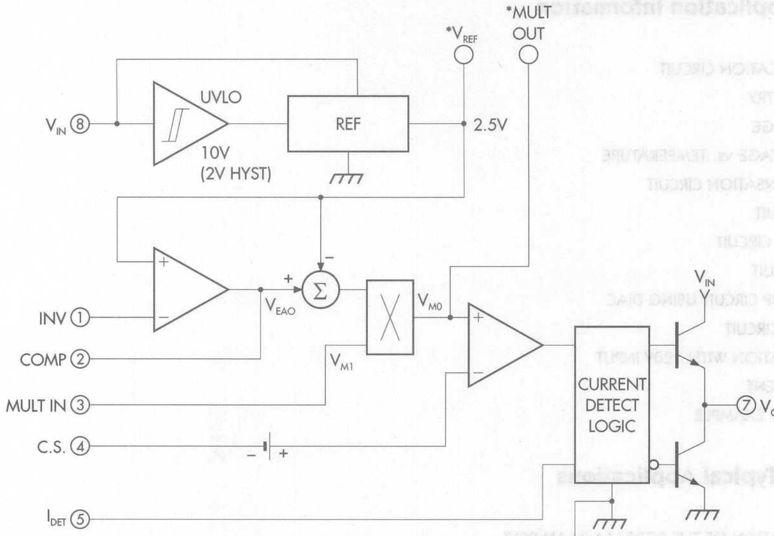
LINFINITY MICROELECTRONICS

SG3561A

Power Factor Controller

Not Recommended For New Designs

BLOCK DIAGRAM / PIN DESCRIPTIONS



* Available only in 14-pin package.

FUNCTIONAL DESCRIPTION

Pin	#	Description
V_{IN}	8	Input supply voltage. $V_{IN} \le 8V$ $I_{IN} \le 0.5mA$ $V_{IN\ MAX} < 25V$; $V_{IN} \ge 10V$ $I_{IN} \le 15mA$
GND	6	Input supply voltage return. Must always be the lowest potential of all the pins.
INV	1	Inverting input of the Error Amplifier. The output of the Boost converter should be resistively divided to 2.5V and connected to this pin.
COMP	2	The output of the Error Amplifier. A feedback compensation network is placed between this pin and the INV pin.
MULT	3	Input to the multiplier stage. The full-wave rectified AC is divided to less than 2V and is connected to this pin.
C.S.	4	Input to the PWM comparator. Current is sensed in the Boost stage MOSFET by a resistor in the source lead, and is fed to this pin through a low-pass filter
I_{DET}	5	A current driven logic input with internal clamp. A second winding on the Boost inductor senses the flyback voltage associated with the zero crossing of the inductor current and feeds it to the I_{DET} pin through a limiting resistor. The logic circuit processes this signal, such that the converter operates in a discontinuous conduction current mode, where there is no current gap between the switching cycles.
V_O	7	PWM output pin. A totem-pole output stage specially designed for direct driving the MOSFET.

LINFINITY MICROELECTRONICS

SG3561A

POWER FACTOR CONTROLLER

NOT RECOMMENDED FOR NEW DESIGNS

FIGURE INDEX

Application Information

Typical Applications

APPLICATION INFORMATION

FUNCTIONAL DESCRIPTION

The operation of the circuit is best described by referring to the diagram in Figure 1.

The multiplier stage generates an output voltage (V_{MO}) from the rectified waveform of the AC input (V_{M1}) and the amplitude of the error amplifier output (V_{EA}). This voltage controls the peak inductor current by turning the power MOSFET off at a threshold, where the current sense voltage (V_{CS}) reaches a given nominal value. This causes the power MOSFET to latch-off until the current in the inductor drops to zero. Once this happens, the secondary winding of the inductor changes its voltage polarity, and gets detected by an internal comparator stage. The polarity of the windings are chosen such that a low I_{DET} voltage turns on the power MOSFET and maintains operation until the above process repeats itself. An external trigger voltage to the IDET is required to start-up the converter until the auxiliary winding of the inductor takes over the operation.

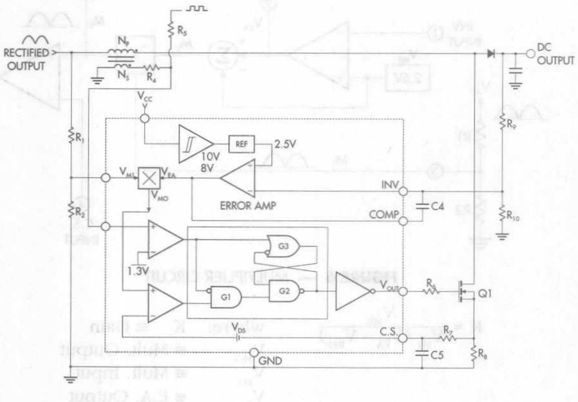


FIGURE 1 — GENERAL APPLICATION CIRCUIT

UNDERVOLTAGE LOCKOUT

The purpose of the undervoltage lockout is to perform two functions: 1) to maintain a low quiescent current during power-up, 2) to guarantee that the IC is fully functional before the output stage is activated. To realize this, a micropower comparator with a start-up threshold of 10V and a built-in hysteresis of 2V is incorporated. This comparator acts as a switch for the pre-regulator stage, which supplies a stable bias to the internal circuitry of the IC. Figure 2 shows a simplified schematic of this section, as well as the external components required, in-order to generate bootstraping voltage from the secondary winding of inductor. The operation of the circuitry is as follows.

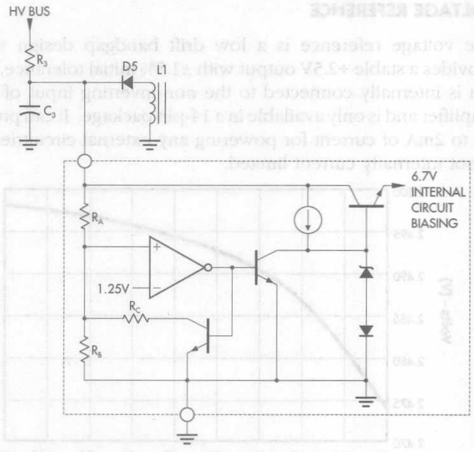


FIGURE 2 — START UP CIRCUITRY

Start-up capacitor C_3 is first charged by the current through resistor R_3. Once this voltage exceeds 10V, then the IC starts operating, requiring more supply current than R_3 can provide. This causes the energy stored in the capacitor to supply the IC with the operating current until the bootstrap winding on L1 takes over the power to maintain operation.

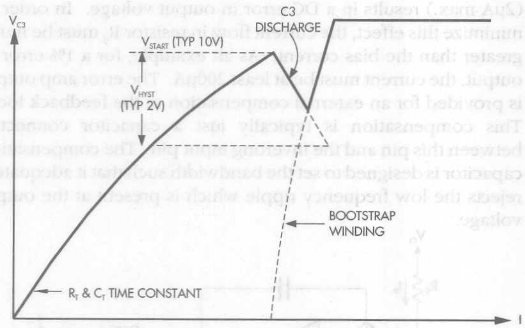


FIGURE 3 — START UP VOLTAGE

$$V_{START} = 1.25\left[\frac{R_A}{R_B \parallel R_C} + 1\right] \qquad V_{HYST} = 1.25\,\frac{R_A}{R_C}$$

APPLICATION INFORMATION

VOLTAGE REFERENCE

The voltage reference is a low drift bandgap design which provides a stable +2.5V output with ±1.5% initial tolerance. This pin is internally connected to the non-inverting input of error amplifier and is only available in a 14-pin package. It can provide up to 2mA of current for powering any external circuitries and is not internally current limited.

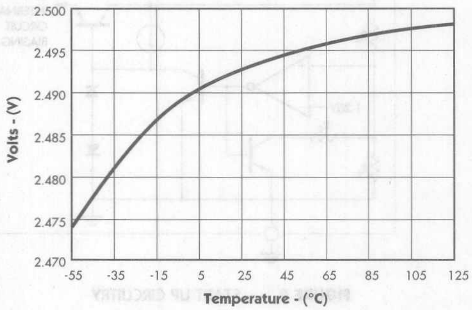
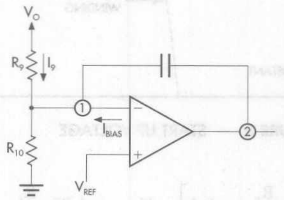


FIGURE 4 — REFERENCE VOLTAGE vs. TEMPERATURE

ERROR AMPLIFIER

The error amplifier is an internally compensated PNP input stage with access to the inverting input and output pin. The N.I. input is internally connected to the voltage reference and is available only in a 14-pin package. The amplifier is designed for an open loop gain of 85dB, along with a typical bandwidth of 1MHz and 57 degrees of phase margin. The amplifier's input bias current (2µA max.) results in a DC error in output voltage. In order to minimize this effect, the current flow in resistor R_9 must be much greater than the bias current; As an example, for a 1% error in output, the current must be at least 200µA. The error amp output is provided for an external compensation of the feedback loop. This compensation is typically just a capacitor connected between this pin and the inverting input pin. The compensation capacitor is designed to set the bandwidth such that it adequately rejects the low frequency ripple which is present at the output voltage.



$$BW = \frac{1}{2\pi\, R_9\, C_4}$$

FIGURE 5 — TYPICAL COMPENSATION CIRCUIT

MULTIPLIER

The SG3561A features a one quadrant multiplier stage having two inputs: one is internally driven by a DC voltage (this being the difference of E.A. output and V_{REF} (M2)), and the other (M1) is available for external connection. The output is internally tied to an input of the PWM comparator. The rectified AC input is typically divided down to less than 1V and is connected to the "M1" input by a resistor divider. The output of the multiplier which is a function of both inputs, controls the inductor peak current during each cycle of operation.

The multiplier is mostly linear if the M1 input is limited to less than 1V and the E.A. output is kept below 3.5V (under all specified load and line conditions). The output clamps to a maximum value of 0.9V typically if the E.A. output is higher than 4V and V_{M1} = 1V.

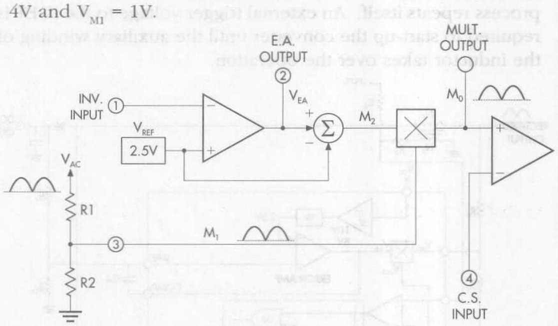


FIGURE 6 — MULTIPLIER CIRCUIT

$$K = \frac{V_{M0}}{V_{M1}\,(V_{EA} - V_{REF})}$$

where: K ≡ Gain
V_{MO} ≡ Mult. Output
V_{M1} ≡ Mult. Input
V_{EA} ≡ E.A. Output

CURRENT SENSE COMPARATOR / PWM LATCH

Current Sense comparator is configured as a PNP input differential stage with one input internally tied to the multiplier output and the other available for current sensing. Current is converted to voltage using an external sense resistor in a series with the power MOSFET (Q1). When voltage across this resistor exceeds the threshold set by the multiplier output, the current sense comparator terminates the gate drive to Q1, as well as resetting the PWM latch. The latch ensures that the output remains in a low state once the switch current falls back to zero.

An offset is built into current sense input to ensure that the output remains in a low state when the load is removed from the output of the converter. This offset is guaranteed to be higher than the multiplier offset during the above condition.

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

CURRENT SENSE COMPARATOR / PWM LATCH (continued)

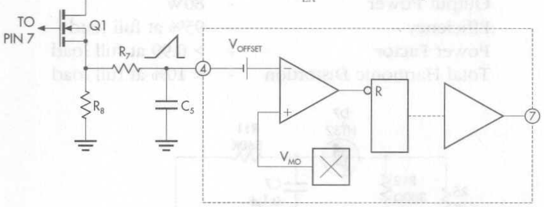
Sense resistor R_8 is designed according to the following formula:

$$R8 \le \frac{V_{MO}}{I_{L\,MAX}} \qquad \text{where: } K \equiv \text{Gain}$$

$V_{MO} \equiv$ Mult. Output under min. line condition

$V_{M1} \equiv$ Mult. Input

$V_{EA} \equiv$ E.A. Output



R7 and C5 form a low pass filter to eliminate the leading edge current spike.

FIGURE 7 — CURRENT SENSE CIRCUIT

PWM DRIVER STAGE

The SG3561A output driver is designed for direct driving of power MOSFETs. It is a totem pole stage with ±0.5A peak current capability. This typically results in a 100 nanosecond rise and fall times into a 1000pF capacitive load. Additionally, the output is held low during the under voltage condition to ensure that the power MOSFET remains in the off state.

CURRENT DETECT LOGIC

The function of "current detect logic" is to sense the operating state of the boose inductor and to enable the output driver accordingly. To achieve this, the downward slope of the inductor current is detected by monitoring the voltage across a separate winding and is connected to the detector input (I_{DET}) pin. Once the inductor current drops to zero, the sensed voltage reverses, setting the I_{DET} input to a low-level, thus enabling the output driver. Since this is a negative voltage, a level shifter as shown in Figure 8 is provided to prevent the I_{DET} pin from going below the ground. The maximum current drawn from this pin must be limited to less than 3mA.

A high level voltage occurs when the inductor discharges. Referring to Figure 9, once the C.S. comparator inhibits the output driver and resets the flip-flop, the inductor voltage reverses and sets the I_{DET} pin to a high level. This ensures the reset instruction of the current sense comparator and reduces its noise susceptibility. An internal zener diode with maximum current capability of 3mA limits the positive voltage swing to 7 volts typically.

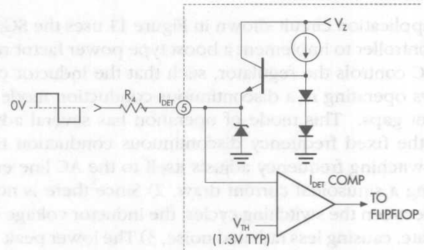


FIGURE 8 — I_{DETECT} INPUT CIRCUIT

Since the output driver is inhibited during the power-on cycle, an external trigger signal is required to start-up the converter before the I_{DET} winding takes over the operation. The trigger signal can be derived either from the second stage of the converter (i.e. the ballast voltage generator), or if stand alone operation is desired from a circuit as shown in Figure 9. Additionally, this signal should be low enough that the voltage from the detector winding is allowed to dominate during the normal operation.

The equations below describe the selection of R_4 and R_5 in Figure 10.

$$2500\ V_{WP} \ge R_4 \ge 400V_{WP} \qquad \text{where } V_{WP} \equiv \text{Peak detector voltage}$$

$$R_5 = 0.8\ R_4\left(\frac{V_{TR}}{1.6}\right) \qquad V_{TR} \equiv \text{Trigger voltage}$$

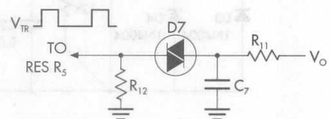


FIGURE 9 — TYPICAL START UP CIRCUIT USING DIAC

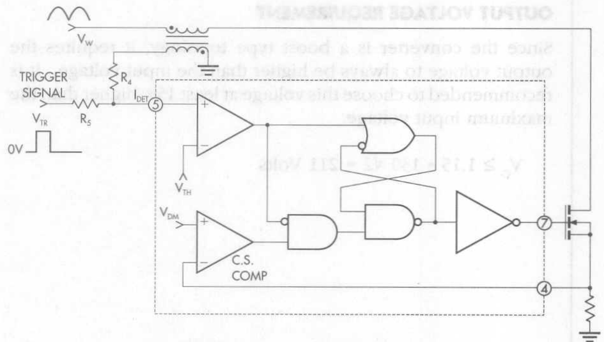


FIGURE 10 — I_{DETECT} LOGIC CIRCUIT

NOT RECOMMENDED FOR NEW DESIGNS

APPLICATION INFORMATION

TYPICAL APPLICATION

The application circuit shown in Figure 11 uses the SG3561A as the controller to implement a boost type power factor regulator. The IC controls the regulator, such that the inductor current is always operating in a discontinuous conduction mode with no current gaps. This mode of operation has several advantages over the fixed frequency discontinuous conduction mode: 1) The switching frequency adjusts itself to the AC line envelope, causing a sinusoidal current draw, 2) Since there is no current gap between the switching cycles, the inductor voltage does not oscillate, causing less radiated noise, 3) The lower peak inductor current causes less power dissipation in the power MOSFET.

A set of formulas have been derived specifically for this mode, and are used throughout the design procedure:

The following are specifications for the boost converter:

Input Voltage Range	-	100 to 130V RMS
Output Voltage	-	230V DC
Output Power	-	80W
Efficiency	-	95% at full load
Power Factor	-	> 0.99 at full load
Total Harmonic Distortion	-	< 10% at full load

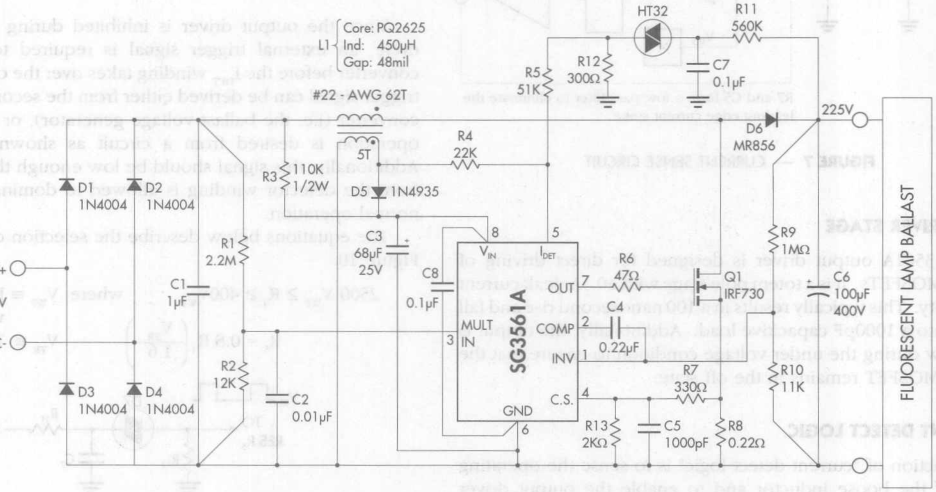


FIGURE 11 — TYPICAL APPLICATION WITH 120V INPUT

OUTPUT VOLTAGE REQUIREMENT

Since the converter is a boost type topology, it requires the output voltage to always be higher than the input voltage. It is recommended to choose this voltage at least 15% higher than the maximum input voltage.

$$V_O \geq 1.15 * 130 \sqrt{2} = 211 \text{ Volts}$$

INDUCTOR PEAK CURRENT

It can be shown by referring to Figure 12 that the inductor peak current is always twice the average input current.

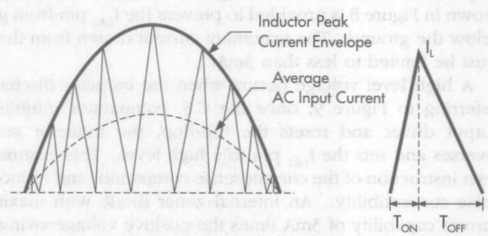


FIGURE 12 — INDUCTOR CURRENT

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

INDUCTOR PEAK CURRENT (continued)

$$I_{IN(t)} = \sum AVE\,[I_L\,(t)]$$

$$I_{IN} = \frac{1}{T}\left[\frac{(I_L)\,(T)}{2}\right]\frac{I_L}{2}$$

$$I_{INpeak} = I_P = \frac{I_{LP}}{2}$$

I_{LP} = Inductor peak current at peak input voltage.

Maximum peak input current can be calculated by using:

$$I_P = \frac{2P_O}{\eta V_P}$$

where: $\eta \equiv$ Converter efficiency
$V_P \equiv$ Peak AC input voltage

assuming: $\eta = 95\%$, $P_O = 80W$, $V_{Pmin} = 100\sqrt{2} = 141$

$$I_P = \frac{2 * 80}{(.95)\,(141)} = 1.2A$$

$$I_{LP/min\,AC} = 2 * 1.2 = 2.4A$$

INDUCTOR DESIGN

The most important part of the circuit is to design the energy storage element. To do this, we use the following equation to calculate the inductance value:

$$L_1 = \frac{\eta \frac{V_O - V_P}{V_O}\,T\,V_P^{\,2}}{4\,P_O}$$

where: $\eta \equiv$ Efficiency
$V_O \equiv$ Output DC Voltage
$V_P \equiv$ Peak AC Input Voltage
$T \equiv$ Switching period
$P_O \equiv$ Output Power

$$L_1 = \frac{.95\left(\frac{230 - 120\sqrt{2}}{230}\right)20 * 10^{-6} * (120\sqrt{2})^2}{4 * 80} = 448\mu H$$

Once the inductance is calculated, we can either use the area product method (AP) or other K_g (based on copper losses method), for selecting proper core. In this example, we apply the K_g approach using the following steps:

Step 1: Calculate K_g using

$$K_g = \frac{\Omega}{P_{CU}}\left(\frac{L_1 I_{LP}^{\,2}}{B}\right)^2$$

where: $L_1 \equiv$ Required inductance
$\Omega \equiv 1.724 * 10^{-8}$ m
$B \equiv$ Maximum flux density
$I_{LP} \equiv$ Maximum peak inductor current
$P_{CU} \equiv$ Maximum copper dissipation

INDUCTOR DESIGN (continued)

Assume: $P_{CU} = 1.6W$ (2% of total output)

$$K_g = \frac{1.724 * 10^{-8}}{1.6}\left[\frac{450 * 10^{-6} * (2.4)^2}{0.15}\right]^2 = 3.21 * 10^{-12}\ m^5$$

Step 2: Choose a core with higher K_g than the one calculated in Step 1.

$$K_g/core = k\,\frac{A_W\,A_E^{\,2}}{l_W}$$

where: $k \equiv$ Winding coefficient (typ. k=0.4)
$A_W \equiv$ Bobbin window area
$A_E \equiv$ Effective core area
$l_W \equiv$ Mean length per turn

K_g factor for TDK PQ2625:
$A_W = 47.7mm^2$
$A_E = 118mm^2$
$l_W = 56.2mm$

$$K_g = 0.4\,\frac{(47.7)\,(118)^2}{56.2}\,(mm)^5 = 4.7 * 10^{-12}\ m^5$$

Step 3: Determine number of turns.

$$N = \frac{L\,I_{LP}}{B\,A_E}$$

$$N = \frac{450 * 10^{-6} * 2.4}{0.15 * 118 * 10^{-6}} = 61\ \text{turns}$$

$$A_{WIRE} = k\,\frac{A_W}{N} = 0.4\,\frac{47.7}{61} = 0.31mm^2 = 480mil^2$$

choose #22 AWG with r = 0.0165Ω/feet resistance.

$$R_W = N * l_W * r$$
$$R_W = 0.185\Omega$$

Step 4: Calculate air gap.

$$l_g = \frac{\mu_O\,N^2\,A_E}{L}$$

$$l_g = \frac{4\pi * 10^{-7} * (61)^2 * 118 * 10^{-6}}{450 * 10^{-6}} = 0.122cm = 48\ mil$$

Step 5: $N_S \approx N_P\,\frac{V_S}{V_O}$

$$N_S = 61\,\frac{15}{230} = 4T$$ where: $V_S \equiv$ secondary voltage

N_S may be adjusted to account for the drop in start-up capacitor.

APPLICATION INFORMATION

POWER MOSFET SELECTION

The voltage rating of MOSFET and rectifier must be higher than the maximum value of the output voltage.

$V_{DS} \geq 1.2V_{O\,MAX}$ $\qquad V_{DS} \geq 282V$

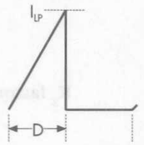
The RMS current can be approximated by multiplying the RMS current at the peak of the line by 0.7.

$I_{RMS} = 0.7\ I_{LP} \sqrt{D/3}$ $\qquad D \equiv$ On-time duty cycle

$D = 0.39$ at $V_{AC} = 100V$

$I_{LPI} = 2.4A$

$I_{RMS} = (0.7)\,(2.4)\,(\sqrt{.39/3}) = 0.61A$



$$R_{DS} \leq \frac{P_{DC}}{I_{RMS}^{\;2}}$$

I_{RMS}/triangle $= I_{LP} \sqrt{D/3}$

$P_{DC} \equiv$ allowable power dissipation

$$R_{DS} \leq \frac{1}{0.61} = 1.6\Omega$$

choose IRF730 with $R_{DS} = 1\Omega$ and $V_{DS} = 400V$.

CURRENT SENSE AND MULTIPLIER COMPONENT SELECTION

Resistors R_1 and R_2 are selected such that the peak voltage at M1 input (pin 3) is 1V at the maximum line voltage.

$$\frac{R_1}{R_2} = V_{AC\,PEAK} - 1$$

$$\frac{R_1}{R_2} = 183 \qquad \text{if } \mathbf{R_1 = 2.2M} \qquad \text{then } R_2 = 12K$$

The value of R_8 can be selected using the following equations:

$V_{M0} = k\ V_{M2} * V_{M1}$ $\qquad V_{M1}$ = Maximum voltage at M1 input under min. line condition

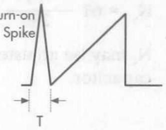
$V_{M0} = (0.75)\ (3.5 - 2.5)\ (0.77) = 0.58$

$$R_8 = \frac{V_{MO}}{I_{LP}} = \frac{0.58}{2.4} = \frac{0.58}{2.4} = 0.24\Omega \qquad \text{choose } R_8 = 0.22\Omega$$

To eliminate the turn-on current spike, a low pass filter with a high corner frequency must be designed such that:

$R_7C_4 \geq 1.6T$

if $T = 100$nsec



$R_7C_4 \geq 0.16\mu$sec

assuming $C_4 = 1000$pF $\qquad R_7 \geq 160\Omega$

The values of R_7 and C_4 may be optimized further based on each specific application. Additionally R_{13} can be used to adjust the overall loop gain in order to maintain regulation at the minimum input voltage.

ERROR AMPLIFIER COMPONENT SELECTION

The values of R_9 and R_{10} are calculated based on the operating output voltage. The value of C_5 is mainly selected to reject the 120Hz ripple associated with the output voltage. Lack of adequate ripple rejection causes input current distortion; however, too much rejection will make a slow loop response and a high voltage overshoot during the turn-on.

$$\frac{R_9}{R_{10}} = \frac{V_O}{V_{REF}} - 1$$

$$\frac{R_9}{R_{10}} = \frac{230}{2.5} - 1 = 91$$

assuming $R_9 = 1M\Omega$ $\qquad$ Then: $R_{10} = 11K$

For output voltages higher than 250V, safety regulations may require two ¼W resistors to be placed in series.

Assuming a 40dB rejection at 120Hz:

$$\text{Gain} = \frac{1}{2\pi\, f\, R_9\, C_5} \qquad \text{Gain/120Hz} \leq 0.01$$

$$C_5 \geq \frac{100}{2\pi(120)(10^6)}$$

$C_5 \geq 0.133\mu$f $\qquad$ choose $C_5 = 0.22\mu$f

$$BW = \frac{1}{2\pi\ R_9\ C_5} = \frac{1}{2\pi\ (10^6)(.22 * 10^{-6})} = 0.72\text{Hz}$$

INPUT RECTIFIER AND CAPACITOR SELECTION

The current through each diode is a half-wave rectified sine wave. The maximum current happens at minimum line with a peak value of 1.2A.

$$I_{AVE} = \frac{I_{PEAK}}{\pi} = \frac{1.2}{\pi} = 0.38A$$

choose **1N4004 with 1A rating.**

$P_{DISS} = (I_{AVE})\ (V_F) = 0.38 * 0.9 = 0.344W$

$T_J = T_A + P_D \times \theta_{JA}$ $\qquad$ assuming $\theta_{JA} = 65°C/W$ for 1/8" lead length.

$T_J = 80 + (.344)(65) = 102°C$

APPLICATION INFORMATION

INPUT RECTIFIER AND CAPACITOR SELECTION (continued)

Assuming φ is the percentage of allowable input current ripple, C_1 can be calculated using the following equations:

$$R_{EFF} = \frac{2\,P_O}{\eta\,I_P^2}$$

$$C_1 \geq \frac{1}{\varphi\,2\pi\,R_{EFF}\,f_{SW}}$$

$f_{SW} \equiv$ Switching frequency of inductor current at peak input voltage.

if $\varphi = 3\%$

$$R_{EFF} = \frac{2 * 80}{(.95)(1.2)^2} = 117\Omega$$

$$C_1 \geq \frac{1}{(.03)(2\pi)(117)(50000)} = 0.9\mu F$$

choose **1µF, 250V capacitor**.

BIAS SUPPLY COMPONENT SELECTION

A bleeding resistor (R_3) off of either output voltage or capacitor C_1 can be selected such that it provides sufficient start-up current for the IC, as well as charging the start-up capacitor C_3.

$$R_3 = \frac{V_{P\,MIN}}{I_{ST}}$$

$$R_3 = \frac{140}{0.5 * 10^{-3}} = 280K$$

$$P_{R3} = \frac{V_{IN\,MAX}}{R_3} \leq 0.25W$$

$$R_3 \geq 4V_{IN\,MAX}^2$$

$I_{ST} \equiv$ Start-up current
$V_{P\,MIN} \equiv$ Peak AC voltage at min. AC line
$V_{IN\,MAX} \equiv$ Max. RMS input

$280K \geq R_3 \geq 68K$ choose **R_3 = 110K**

The start-up capacitor must be chosen such that it supplies power to the IC until the voltage on the bootstrap winding exceeds the start threshold (this is typically around 10 volts). C_3 must also be designed to have low ripple voltage at twice the line frequency.

$$C_3\,(\Delta V_R) \geq \frac{I}{2\,f_{LINE}\,\Delta V_R}$$

$$C_3\,(\Delta T) \geq \frac{I\Delta T}{\Delta V_H}$$

$I \equiv$ Operating current
$f_{LINE} \equiv$ Line frequency
$\Delta V_r \equiv$ Ripple voltage
$\Delta T \equiv$ Time allowed for bootstrap winding to reach start-up threshold

$$C_3\,(\Delta V_R) \geq \frac{15 * 10^{-3}}{2 * 60 * 2} = 62\mu F$$

assuming ΔT = 2ms

$$C_3\,(\Delta T) \geq \frac{15 * 10^{-3} * 2 * 10^{-3}}{1.8V} = 17\mu f$$

choose C_3 = 68µF.

OUTPUT CAPACITOR SELECTION

There are mainly two criterias for selecting the output capacitor: A large enough capacitance to maintain a low ripple voltage, and a low ESR value in order to prevent high power dissipation due to RMS currents.

The output capacitance can be approximated from the following equation:

$$C_6 \geq \frac{I_{DC}}{2\pi\,f_{LINE}\,\Delta V}$$

where: $I_{DC} \equiv$ DC output current
$\Delta V \equiv$ Output ripple

$$I_{DC} = \frac{80}{230} = 0.348A$$

assuming 5% peak to peak ripple,

$$C_6 \geq \frac{0.348}{2\pi\,(60)\,(11.5)} = 81\mu F$$

choose **C_6 = 100µF.**

CURRENT DETECT COMPONENT SELECTION

The values of R_4 and R_5 can be calculated using the following equations:

$$400V_{WP} \geq R_4 \geq 2500V_{WP}$$

$$R_5 = 0.8R_4\left(\frac{V_{TR}}{1.6}\right)$$

where:

$V_{WP} \equiv$ Maximum detector winding voltage

$V_{TR} \equiv$ Trigger voltage

APPLICATION INFORMATION

CURRENT DETECT COMPONENT SELECTION (continued)

Assuming V_{WP} = 15V and peak trigger voltage from the start-up circuitry is 7V, the values R_4 and R_5 using above formulas are:

$6K\Omega \leq R_4 \leq 37.5K\Omega$ choose $R_4 = 22K$

$R5 = 0.8\,(22)\left(\frac{7}{1.6} - 1\right) = 59.4K\Omega$ choose $R_5 = 51K$

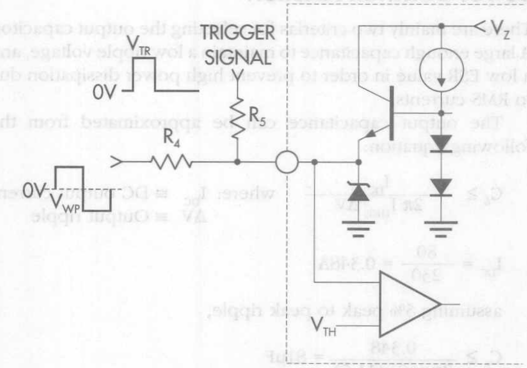


FIGURE 13 — CURRENT DETECT EXAMPLE

NOT RECOMMENDED FOR NEW DESIGNS

TYPICAL APPLICATIONS

120V

Pin numbers are for 8-pn dip package.

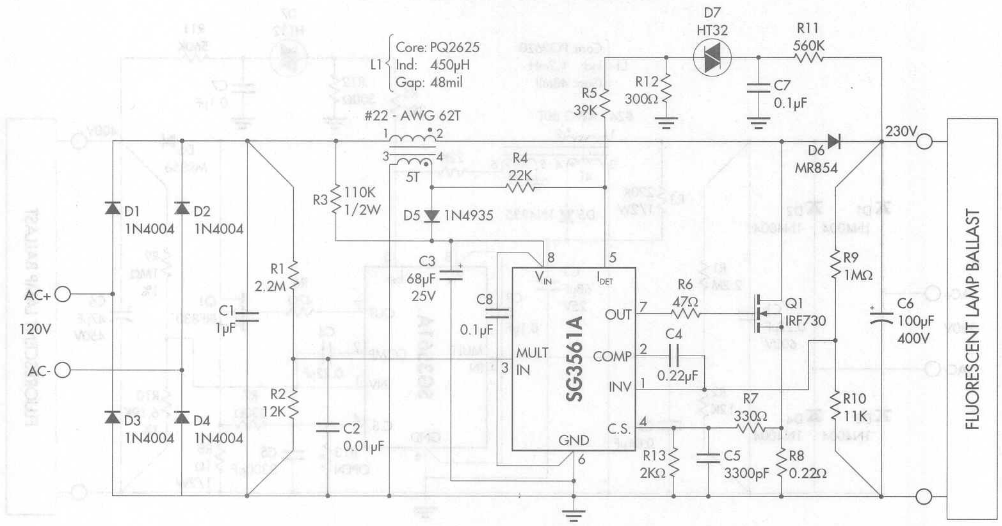


FIGURE 14 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specification **120VAC Input — 230VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	SG3561AM	Linfinity	C1	1µF/250V	
L1	PQ2625/H7C1 Core	TDK	C2	0.01µF/50V	
Q1	IRF730, 400V	I.R.	C3	68µF/25V	
D1-D4	1N4004, Diode, 1A	Motorola	C4	0.22µF/50V	
D5	1N4935, Diode, 1A	Motorola	C5	3300pF/50V	
D6	MR854, 3A, 400V	Motorola	C6	100µF/400V	
D7	HT32, DIAC	TECCOR	C7	0.1µF/50V	
R1	2.2MΩ		C8	0.1µF/50V	
R2	12KΩ				
R3	110K, ½W				
R4	22K				
R5	51K				
R6	47Ω				
R7	330Ω				
R8	0.22Ω, ½W - Carbon type				
R9	1MΩ, 1% Res				
R10	11KΩ, 1% Res				
R11	560KΩ				
R12	300Ω				
R13	2KΩ				

NOT RECOMMENDED FOR NEW DESIGNS

TYPICAL APPLICATIONS

220V

Pin numbers are for 8-pn dip package.

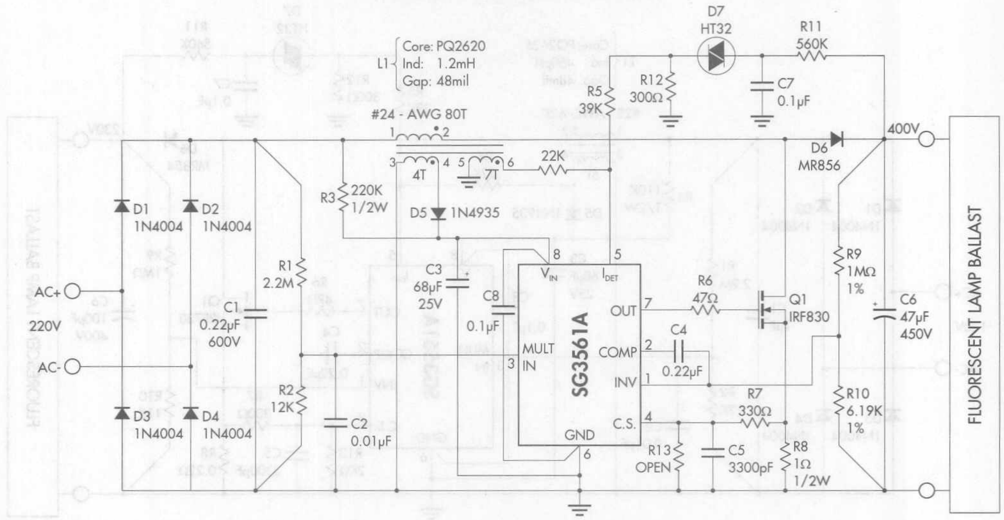


FIGURE 15 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specification **220VAC Input — 400VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	SG3561A	Linfinity	C1	0.22µF/600V	
L1	PQ262/H7C1 Core	TDK	C2	0.01µF/50V	
Q1	IRF830, 500V	I.R.	C3	68µF/25V	
D1-D4	1N4004, Diode, 1A	Motorola	C4	0.22µF/50V	
D5	1N4935, Diode, 1A	Motorola	C5	3300pF/50V	
D6	MR856, 3A, 600V	Motorola	C6	47µF/450V	
D7	HT32, DIAC	Teccor	C7	0.1µF/50V	
R1	2.2MΩ		C8	0.1µF/50V	
R2	12KΩ				
R3	220K, ½W				
R4	22K				
R5	39K				
R6	47Ω				
R7	330Ω				
R8	1Ω, ½W - Carbon type				
R9	1MΩ, 1% Res				
R10	2.7MΩ				
R11	560KΩ				
R12	300Ω				
R13	2KΩ				

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS

277V

Pin numbers are for 8-pn dip package.

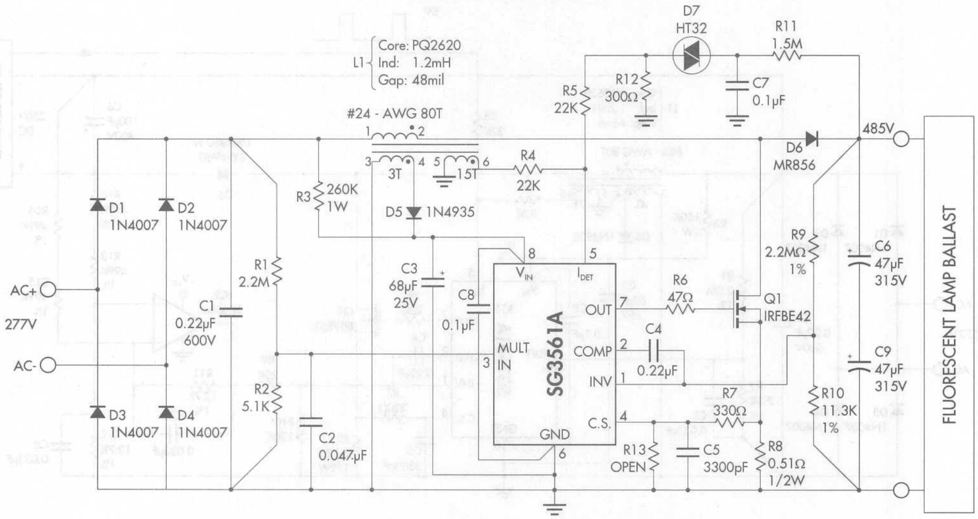


FIGURE 16 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specification **277VAC Input — 485VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	SG3561A	Linfinity	C1	0.22µF/600V	
L1	PQ2620/H7C1 Core	TDK	C2	0.047µF/50V	
Q1	IRFBE42, 600V	I.R.	C3	68µF/25V	
D1-D4	1N4007, Diode, 1A	Motorola	C4	0.22µF/50V	
D5	1N4935, Diode, 1A	Motorola	C5	3300pF/50V	
D6	MR856, 3A, 600V	Motorola	C6, C9	47µF/315V	
D7	HT32, DIAC	TECCOR	C7	0.1µF/50V	
R1	2.2MΩ		C8	0.1µF/50V	
R2	5.1KΩ				
R3	260KΩ, 1W				
R4	22KΩ				
R5	22KΩ				
R6	47Ω				
R7	330Ω				
R8	0.51Ω, ½W - Carbon type				
R9	2.2MΩ, 1% Res				
R10	11.3KΩ, 1% Res				
R11	1.5KΩ				
R12	300Ω				
R13					

LINFINITY MICROELECTRONICS

NOT RECOMMENDED FOR NEW DESIGNS

TYPICAL APPLICATIONS

277V - Buck Boost Application

Pin numbers are for 8-pn dip package.

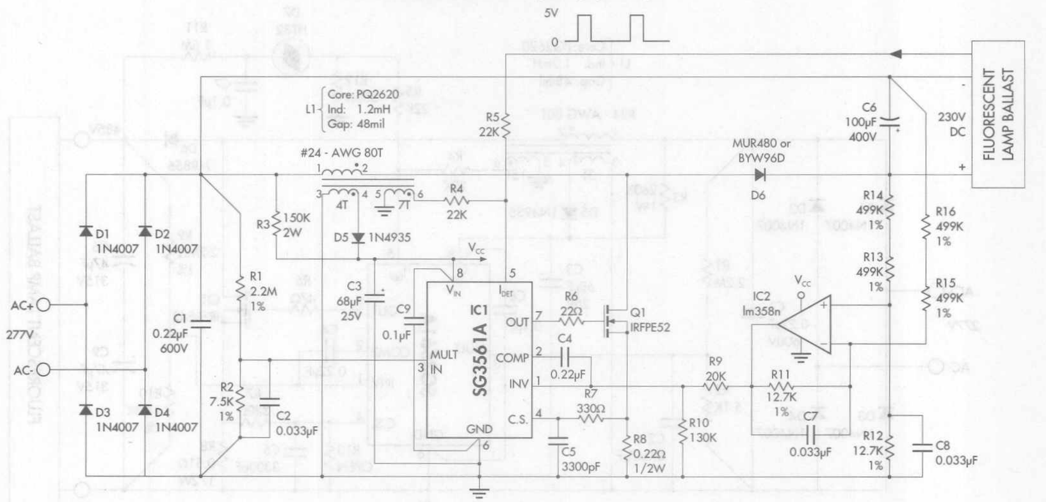


FIGURE 17 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specification **90-265VAC Input — 230VDC / 80W Output**

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	SG3561A	Linfinity	C1	0.22µF/600V	
IC2	LM358N		C2	0.033µF/50V	
L1	PQ2620/H7CI Core	TDK	C3	68µF/25V	
Q1	IRFPE52, 800V	I.R.	C4	0.22µF/50V	
D1-D4	1N4007, Diode, 1A	Motorola	C5	3300pF/50V	
D5	1N4935, Diode, 1A	Motorola	C6	100µF/400V	
D6	BYW96D, 4A, 800V		C7, C8	0.033µF/50V	
R1	2.2MΩ, 1%		C9	0.1µF/50V	
R2	7.5KΩ, 1%				
R3	150K, 2W				
R4	22kΩ				
R5	22K				
R6	22Ω				
R7	330Ω				
R8	0.22Ω, ½W				
R9	20K				
R10	130K				
R11	12.7K, 1%				
R12	12.7K, 1%				
R13, 14	499K, 350V				
R15, 16	499K, 350V				

LINFINITY MICROELECTRONICS

TYPICAL APPLICATIONS

90 - 265V

Pin numbers are for 8-pn dip package.

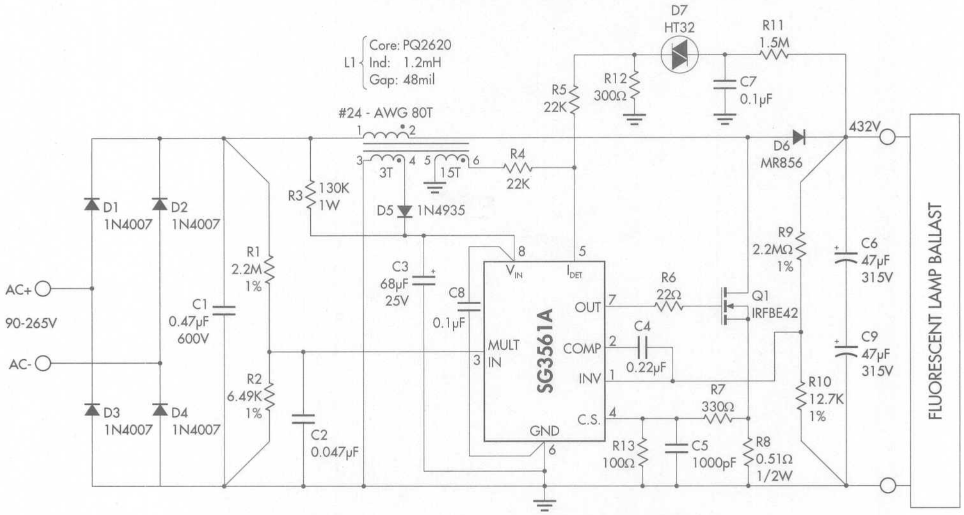


FIGURE 18 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specification — 90-265VAC Input — 432VDC / 80W Output

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC	SG3561A	Linfinity	C1	0.47µF/600V	
L1	PQ2620/H7C1 Core	TDK	C2	0.047µF/50V	
Q1	IRFBE42, 600V	I.R.	C3	68µF/25V	
D1-D4	1N4007, Diode, 1A	Motorola	C4	0.22µF/50V	
D5	1N4935, Diode, 1A	Motorola	C5	1000pF/50V	
D6	MR856, 3A, 600V	Motorola	C6, C9	47µF/315V	
D7	HT32, DIAC	TECCOR	C7	0.1µF/50V	
R1	2.2MΩ, 1%		C8	0.1µF/50V	
R2	6.49K, 1%				
R3	130K, 1W				
R4	22kΩ				
R5	22K				
R6	22Ω				
R7	330Ω				
R8	0.51Ω, ½W - Carbon type				
R9	2.2MΩ, 1% Res				
R10	12.7KΩ, 1% Res				
R11	1.5KΩ				
R12	300Ω				
R13	100Ω				

Notes

SG723

PRECISION VOLTAGE REGULATOR

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic voltage regulator is designed for use with either positive or negative supplies as a series, shunt, switching, or floating regulator with currents up to 150mA. Higher current requirements may be accommodated through the use of external NPN or PNP power transistors. This device consists of a temperature compensated reference amplifier, error amplifier, power series pass transistor, current limit, and remote shutdown circuitry.

The SG723 will operate over the full military ambient temperature range of -55°C to 125°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

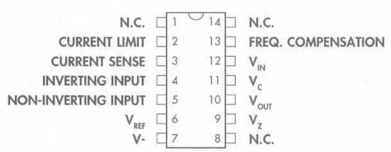
KEY FEATURES

- POSITIVE OR NEGATIVE SUPPLY OPERATION
- SERIES, SHUNT, SWITCHING OR FLOATING OPERATION
- LOW LINE AND LOAD REGULATION
- OUTPUT ADJUSTABLE FROM 2V TO 37V
- OUTPUT CURRENT TO 150mA
- LOW STANDBY CURRENT DRAIN
- 0.002%/°C AVERAGE TEMPERATURE VARIATION

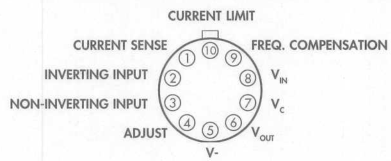
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/10201BHA - JAN723F
- MIL-M38510/10201BIA - JAN723T
- MIL-M38510/10201BCA - JAN723J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

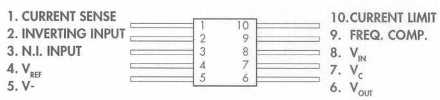
PACKAGE PIN OUTS



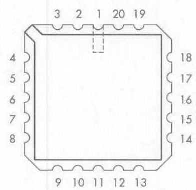
J PACKAGE
(Top View)



T PACKAGE
(Top View)



F PACKAGE
(Top View)



1. FREQ. COMP.
2. CURRENT LIMIT
3. CURRENT SENSE
4. N.C.
5. INVERTING INPUT
6. N.C.
7. N.I. INPUT
8. V_{REF}
9. N.C.
10. V-
11. N.C.
12. V_Z
13. N.C.
14. V_{OUT}
15. N.C.
16. N.C.
17. N.C.
18. V_C
19. N.C.
20. V_{IN}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	T T0-100 Metal Can 10-pin	F Ceramic Flatpack 10-pin	L Ceramic LCC 20-pin
-55 to 125	SG723J	SG723T	—	SG723L
MIL-STD-883	SG723J/883B	SG723T/883B	—	SG723L/883B
JAN SPEC.	JAN723J	JAN723T	JAN723F	—

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG7800A/SG7800 Series

POSITIVE FIXED VOLTAGE REGULATOR

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG7800A/SG7800 series of positive regulators offer self contained, fixed-voltage capability with up to 1.5A of load current and input voltage up to 50V (SG7800A series only). These units feature a unique on-chip trimming system to set the output voltages to within ±1.5% of nominal on the SG7800A series, ±2.0% on the SG7800 series. The SG7800A versions also offer much improved line and load regulation characteristics. Utilizing an improved bandgap reference design, problems have been eliminated that are normally associated with the Zener diode references, such as drift in output voltage and large changes in the line and load regulation.

All protective features of thermal shutdown, current limiting, and safe-area control have been designed into these units and since these regulators require only a small output capacitor for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used.

Product is available in hermetically sealed TO-257, TO-3, TO-39 and TO-66 power packages.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

KEY FEATURES

- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG7800A
- INPUT VOLTAGE RANGE TO 50V MAX. (SG7800A)
- TWO VOLT INPUT-OUTPUT DIFFERENTIAL
- EXCELLENT LINE AND LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: 5V, 6V, 8V, 12V, 15V, 18V, 20V, 24V

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/10702BXA-JAN7805T
- MIL-M38510/10706BYA-JAN7805K
- MIL-M38510/10703BXA-JAN7812T
- MIL-M38510/10707BYA-JAN7812K
- MIL-M38510/10704BXA-JAN7815T
- MIL-M38510/10708BYA-JAN7815K
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

(See next page for Package Pinouts)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 125	SG78xxK	—	—	—	—
-55 to 125	SG78xxAK*	SG78xxAR*	SG78xxAIG*	SG78xxAT*	—
MIL-STD-883	SG78xxAK/883B*	SG78xxAR/883B*	SG78xxAIG/883B*	SG78xxAT/883B*	SG78xxL/883B
JAN SPEC.	JAN7805K	—	—	JAN7805T	—
	JAN7812K	—	—	JAN78012T	—
	JAN7815K	—	—	JAN7815T	—
DESC	SG7805AK/DESC	SG7805AR/DESC	SG7805AIG/DESC	SG7805AT/DESC	SG7805AL/DESC
	SG7805AK/DESC	SG7806AR/DESC	—	SG7806AT/DESC	—
	SG7808AK/DESC	SG7808AR/DES	—	SG7808AT/DESC	—
	SG7812AK/DESC	SG7812AR/DESC	SG7812AIG/DESC	SG7812AT/DESC	SG7812AL/DESC
	SG7815AK/DESC	SG7815AR/DESC	SG7815AIG/DESC	SG7815AT/DESC	SG7815AL/DESC
	SG7824AK/DESC	SG7824AR/DESC	—	SG7824AT/DESC	—

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.
"xx" to be replaced by output voltage of specific fixed regulator.

FOR FURTHER INFORMATION CALL (714) 898-8121

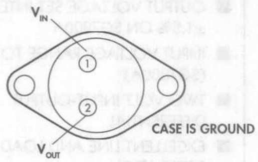
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG7800A/SG7800 Series

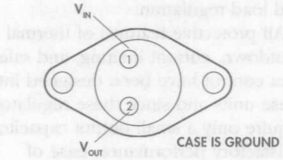
POSITIVE FIXED VOLTAGE REGULATOR

NOT RECOMMENDED FOR NEW DESIGNS

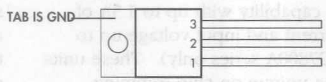
PACKAGE PIN OUTS



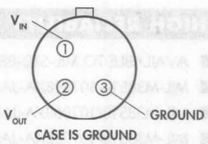
K PACKAGE
(Top View)



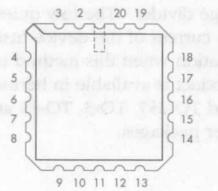
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



1. N.C.	11. N.C.
2. V_{IN}	12. V_{OUT}
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. N.C.	15. V_O SENSE
6. N.C.	16. N.C.
7. GND	17. V_{IN}
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. V_{OUT}	20. N.C.

L PACKAGE
(Top View)

LINFINITY
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THE INFINITE POWER OF INNOVATION

SG7900A/SG7900 Series

NEGATIVE FIXED VOLTAGE REGULATOR

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG7900A/SG7900 series of negative regulators offer self-contained, fixed-voltage capability with up to 1.5A of load current. With a variety of output voltages and four package options this regulator series is an optimum complement to the SG7800A/SG7800, SG140 line of three terminal regulators.

These units feature a unique bandgap reference which allows the SG7900A series to be specified with an output voltage tolerance of ±1.5%. The SG7900A versions also offer much improved line regulation characteristics.

All protective features of thermal shutdown, current limiting, and safe-area control have been designed into these units and, since these regulators require only a single output capacitor (SG7900 series) or a capacitor and 5mA minimum load (SG120 series) for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used, especially for the SG120 series.

These devices are available in hermetically sealed TO-257, TO-3, TO-39 and TO-66 power packages.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

KEY FEATURES

- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG7900A
- OUTPUT CURRENT TO 1.5A
- EXCELLENT LINE & LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: -5V, -5.2V, -6V, -8V, -12V, -15V, -18V, -20V
- CONTACT FACTORY FOR OTHER VOLTAGE OPTIONS

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/11501BXA-JAN7905T
- MIL-M38510/11505BYA-JAN7905K
- MIL-M38510/11502BXA-JAN7912T
- MIL-M38510/11506BYA-JAN7912K
- MIL-M38510/11503BXA-JAN7915T
- MIL-M38510/11507BYA-JAN7915K
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

(See next page for Package Pinouts)

PACKAGE ORDER INFORMATION

T_A (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 125	SG79xxK	—	—	—	—
-55 to 125	SG79xxAK*	SG79xxAR*	SG79xxAIG*	SG79xxAT*	SG79xxL
MIL-STD-883	SG79xxAK/883B*	SG79xxAR/883B*	SG79xxAIG/883B*	SG79xxAT/883B*	SG79xxL/883B
JAN SPEC.	JAN7905K	—	—	JAN7905T	—
	JAN7912K	—	—	JAN7912T	—
	JAN7915K	—	—	JAN7915T	—
DESC	SG7905AK/DESC	SG7905AR/DESC	SG7905AIG/DESC	SG7905AT/DESC	—
	SG7908AK/DESC	SG7908AR/DESC	SG7908AIG/DESC	SG7908AT/DESC	—
	SG7912AK/DESC	SG7912AR/DESC	SG7912AIG/DESC	SG7912AT/DESC	—
	SG7915AK/DESC	SG7915AR/DESC	SG7915AIG/DESC	SG7915AT/DESC	—

* "A" denotes improved performance over the non-"A" version, non-"A" versions also available.
"xx" to be replaced by output voltage of specific fixed regulator.

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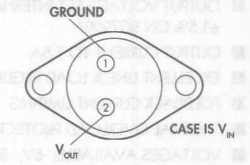
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SG7900A/SG7900 Series

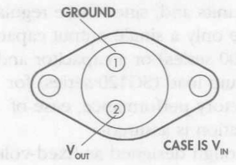
NEGATIVE FIXED VOLTAGE REGULATOR

NOT RECOMMENDED FOR NEW DESIGNS

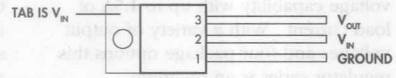
PACKAGE PIN OUTS



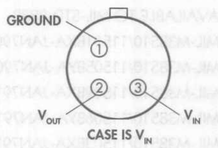
K PACKAGE
(Top View)



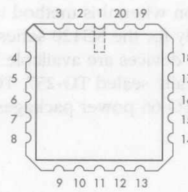
R PACKAGE
(Top View)



IG PACKAGE
(Top View)



T PACKAGE
(Top View)



1. N.C.	11. N.C.
2. V_{IN}	12. N.C.
3. N.C.	13. N.C.
4. V_O	14. N.C.
5. V_O	15. GND
6. N.C.	16. N.C.
7. V_O SENSE	17. GND
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. N.C.	20. V_{IN}

L PACKAGE
(Top View)

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THE INFINITE POWER OF INNOVATION

SM600

SWITCHING REGULATOR POWER OUTPUT STAGES

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SM600/SM601/SM602 and SM610/SM611/SM612 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM600, SM601 and SM602 are optimized for non-isolated Buck and Buck-Boost application, where SM610, SM611 and SM612 are best suited for DC-DC Boost type applications as well as negative output Buck Converters. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

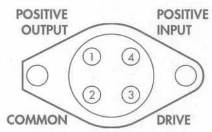
KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 600, 601, 602, 610, 611, 612
- 5A CURRENT CAPABILITY
- DESIGNED AND CHARACTERIZED FOR SWITCHING REGULATOR APPLICATIONS SUCH AS BUCK, BOOST, AND BUCK-BOOST TYPE
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING EFFICIENCY AT 2A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 75ns
  - EFFICIENCY > 85%
- ELECTRICALLY ISOLATED, 4-PIN, TO-66 HERMETIC CASE

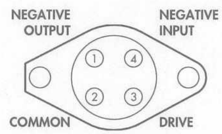
HIGH RELIABILITY FEATURES

- AVAILABLE WITH HIGH RELIABILITY PROCESSING

PACKAGE PIN OUTS



R PACKAGE
(Positive Input/Output)
(Top View)



R PACKAGE
(Negative Input/Output)
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	R Metal Can TO-66 4-pin (Positive)	R Metal Can TO-66 4-pin (Negative)
0 to 70	SM600R	SM610R
	SM601R	SM611R
	SM602R	SM612R
-55 to 125	SM600HRR	SM610HRR
	SM601HRR	SM611HRR
	SM602HRR	SM612HRR

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11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SM625

SWITCHING REGULATOR POWER OUTPUT STAGES

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SM625/SM626/SM627 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM625, SM626 and SM627 are optimized for non-isolated Buck and Buck-Boost application. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

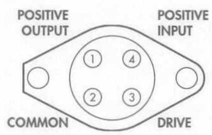
KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 625, 626, 627
- 15A CURRENT CAPABILITY
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING FREQUENCY (TO > 100KHz) RESULTS IN SMALLER INDUCTOR-CAPACITOR FILTER AND IMPROVED POWER SUPPLY RESPONSE TIME
- HIGH OPERATING EFFICIENCY AT 7A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 300ns
  - EFFICIENCY > 85%
- ELECTRICALLY ISOLATED, 4-PIN, TO-66 HERMETIC CASE

HIGH RELIABILITY FEATURES

- AVAILABLE WITH HIGH RELIABILITY PROCESSING

PACKAGE PIN OUTS



R PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	R Metal Can TO-66 4-pin
0 to 70	SM625R
	SM626R
	SM627R
-55 to 125	SM625HRR
	SM626HRR
	SM627HRR

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SM645

SWITCHING REGULATOR POWER OUTPUT STAGES

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SM645/SM646/SM647 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM645, SM646 and SM647 are optimized for non-isolated Buck and Buck-Boost application. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

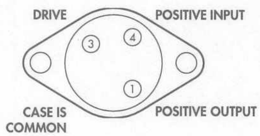
KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 645, 646 & 647
- 15A CURRENT CAPABILITY
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING FREQUENCY (TO > 100KHz) RESULTS IN SMALLER INDUCTOR-CAPACITOR FILTER AND IMPROVED POWER SUPPLY RESPONSE TIME
- HIGH OPERATING EFFICIENCY AT 7A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 300ns
  - EFFICIENCY > 85%

HIGH RELIABILITY FEATURES

- AVAILABLE WITH HIGH RELIABILITY PROCESSING

PACKAGE PIN OUTS



K PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	K Metal Can TO-3 4-Terminal
0 to 70	SM645K
	SM646K
	SM647K
-55 to 125	SM645HRK
	SM646HRK
	SM647HRK

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

UC184xA/284xA/384xA

CURRENT MODE PWM CONTROLLER

PRODUCTION DATA SHEET

DESCRIPTION

The UC184xA family of control ICs provides all the necessary features to implement off-line fixed-frequency, current-mode switching power supplies with a minimum of external components. The current mode architecture demonstrates improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch. The IC includes: A bandgap reference trimmed to ±1% accuracy, an error amplifier, a current sense comparator with internal clamp to 1V, a high current totem pole output stage for fast switching of power MOSFET's, and an externally programmable oscillator to set frequency and maximum duty cycle. The under-voltage lock-out is designed to operate with 250µA typ. start-up current, allowing an efficient bootstrap supply voltage design. Available options for this family of products, such as start-up voltage hysteresis and duty cycle, are summarized below in the Available Options section. The UC184xA family of control ICs is also available in 14-pin SOIC package which makes the Power Output Stage Collector and Ground pins available.

KEY FEATURES

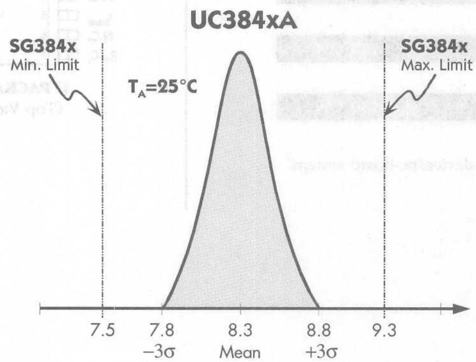
- **LOW START-UP CURRENT.** (0.5mA max.)
- **TRIMMED OSCILLATOR DISCHARGE CURRENT.** (See Product Highlight)
- OPTIMIZED FOR OFF-LINE AND DC-TO-DC CONVERTERS.
- AUTOMATIC FEED FORWARD COMPENSATION.
- PULSE-BY-PULSE CURRENT LIMITING.
- ENHANCED LOAD RESPONSE CHARACTERISTICS.
- UNDER-VOLTAGE LOCKOUT WITH HYSTERESIS.
- DOUBLE PULSE SUPPRESSION.
- HIGH-CURRENT TOTEM POLE OUTPUT.
- INTERNALLY TRIMMED BANDGAP REFERENCE.
- 500KHz OPERATION.
- LOW R_O ERROR AMPLIFIER.

APPLICATIONS

- ECONOMICAL OFF-LINE FLYBACK OR FORWARD CONVERTERS.
- DC-DC BUCK OR BOOST CONVERTERS.
- LOW COST DC MOTOR CONTROL.

PRODUCT HIGHLIGHT

COMPARISON OF UC384xA VS. SG384x DISCHARGE CURRENT



Discharge Current Distribution - mA

AVAILABLE OPTIONS

Part #	Start-Up Voltage	Hysteresis	Max. Duty Cycle
UCx842A	16V	6V	<100%
UCx843A	8.4V	0.8V	<100%
UCx844A	16V	6V	<50%
UCx845A	8.4V	0.8V	<50%

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin
0 to 70	UC384xAM	UC384xADM	UC384xAD	—
-40 to 85	UC284xAM	UC284xADM	UC284xAD	UC284xAY
-55 to 125	—	—	—	UC184xAY

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. UC3842ADMT)

FOR FURTHER INFORMATION CALL (714) 898-8121
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UC184xA/284xA/384xA

Current Mode PWM Controller

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (Low Impedance Source) (V_{CC}) 30V
Supply Voltage (I_{CC} < 30mA) .... Self Limiting
Output Current .... ±1A
Output Energy (Capacitive Load) 5µJ
Analog Inputs (V_{FB} & I_{SENSE}) .... -0.3V to +6.3V
Error Amp Output Sink Current 10mA
Power Dissipation at T_A = 25°C (M Package) 1W
Storage Temperature Range .... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

THERMAL DATA

M PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

D PACKAGE:

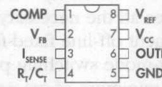
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	120°C/W

Y PACKAGE:

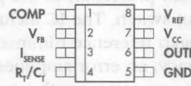
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	130°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

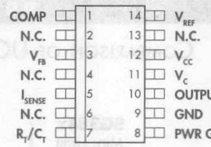
PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)



DM PACKAGE
(Top View)



D PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

UC184xA/284xA/384xA

CURRENT MODE PWM CONTROLLER

PRODUCTION DATA SHEET

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for UC384xA with 0°C ≤ T_A ≤ 70°C, UC284xA with -40°C ≤ T_A ≤ 85°C, UC184xA with -55°C ≤ T_A ≤ 125°C; V_{CC}=15V; R_T=10K; C_T=3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	UC184xA/284xA Min.	UC184xA/284xA Typ.	UC184xA/284xA Max.	UC384xA Min.	UC384xA Typ.	UC384xA Max.	Units
Reference Section									
Output Voltage	V_{REF}	T_J = 25°C, I_L = 1mA	4.95	5.00	5.05	4.90	5.00	5.10	V
Line Regulation		12 ≤ V_{IN} ≤ 25V		6	20		6	20	mV
Load Regulation		1 ≤ I_O ≤ 20mA		6	25		6	25	mV
Temperature Stability (Note 2 & 7)				0.2	0.4		0.2	0.4	mV/°C
Total Output Variation		Over Line, Load, and Temperature	4.9		5.1	4.82		5.18	V
Output Noise Voltage (Note 2)	V_N	10Hz ≤ f ≤ 10kHz, T_J = 25°C		50			50		µV
Long Term Stability (Note 2)		T_A = 125°C, t = 1000hrs		5	25		5	25	mV
Output Short Circuit Current	I_{SC}		-30	-100	-180	-30	-100	-180	mA
Oscillator Section									
Initial Accuracy (Note 6)		T_J = 25°C	47	52	57	47	52	57	kHz
Voltage Stability		12 ≤ V_{CC} ≤ 25V		0.2	1		0.2	1	%
Temperature Stability (Note 2)		T_{MIN} ≤ T_A ≤ T_{MAX}		5			5		%
Amplitude (Note 2)				1.7			1.7		V
Discharge Current		T_J = 25°C, $V_{PIN\,4}$ = 2V	7.8	8.3	8.8	7.8	8.3	8.8	mA
		$V_{PIN\,4}$ = 2V, T_{MIN} ≤ T_A ≤ T_{MAX}	7.5		8.8	7.6		8.8	mA
Error Amp Section									
Input Voltage		$V_{PIN\,1}$ = 2.5V	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current	I_B			-0.3	-1		-0.3	-2	µA
Open Loop Gain	A_{VOL}	2 ≤ V_O ≤ 4V	65	90		65	90		dB
Unity Gain Bandwidth (Note 2)	UGBW	T_J = 25°C	0.7	1		0.7	1		MHz
Power Supply Rejection Ratio (Note 3)	PSRR	12 ≤ V_{CC} ≤ 25V	60	70		60	70		dB
Output Sink Current	I_{OL}	$V_{PIN\,2}$ = 2.7V, $V_{PIN\,1}$ = 1.1V	2	6		2	6		mA
Output Source Current	I_{OH}	$V_{PIN\,2}$ = 2.3V, $V_{PIN\,1}$ = 5V	-0.5	-0.8		-0.5	-0.8		mA
Output Voltage High Level	V_{OH}	$V_{PIN\,2}$ = 2.3V, R_L = 15K to ground	5	6		5	6		V
Output Voltage Low Level	V_{OL}	$V_{PIN\,2}$ = 2.7V, R_L = 15K to V_{REF}		0.7	1.1		0.7	1.1	V
Current Sense Section									
Gain (Note 3 & 4)	A_{VOL}		2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 3)		$V_{PIN\,1}$ = 5V	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 3)	PSRR	12 ≤ V_{CC} ≤ 25V		70			70		dB
Input Bias Current	I_B			-2	-10		-2	-10	µA
Delay to Output (Note 2)	T_{pd}	$V_{PIN\,3}$ = 0 to 2V		150	300		150	300	ns
Output Section									
Output Low Level	V_{OL}	I_{SINK} = 20mA		0.1	0.4		0.1	0.4	V
		I_{SINK} = 200mA		1.5	2.2		1.5	2.2	V
Output High Level	V_{OH}	I_{SOURCE} = 20mA	13	13.5		13	13.5		V
		I_{SOURCE} = 200mA	12	13.5		12	13.5		V
Rise Time (Note 2)	T_R	T_J = 25°C, C_L = 1nF		50	150		50	150	ns
Fall Time (Note 2)	T_F	T_J = 25°C, C_L = 1nF		50	150		50	150	ns
UVLO Saturation	V_{SAT}	V_{CC} = 5V, I_{SINK} = 10mA		0.7	1.2		0.7	1.2	V

(Electrical Characteristics continue next page.)

ELECTRICAL CHARACTERISTICS (Con't.)

Parameter	Symbol	Test Conditions	UC184xA/284xA Min.	UC184xA/284xA Typ.	UC184xA/284xA Max.	UC384xA Min.	UC384xA Typ.	UC384xA Max.	Units
Under-Voltage Lockout Section									
Start Threshold		x842A/4A	15	16	17	14.5	16	17.5	V
		x843A/5A	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operation Voltage After Turn-On		x842A/4A	9	10	11	8.5	10	11.5	V
		x843A/5A	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section									
Maximum Duty Cycle		x842A/3A	94	96	100	94	96	100	%
		x844A/5A	47	48	50	47	48	50	%
Minimum Duty Cycle					0			0	%
Total Standby Section									
Start-Up Current				0.3	0.5		0.3	0.5	mA
Operating Supply Current	I_{CC}			11	17		11	17	mA
Zener Voltage	V_Z	I_{CC} = 25mA	30	35		30	35		V

Notes: 2. These parameters, although guaranteed, are not 100% tested in production.

3. Parameter measured at trip point of latch with $V_{VFB} = 0$.

4. Gain defined as: $A_{VOL} = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$; $0 \le V_{ISENSE} \le 0.8V$.

5. Adjust V_{CC} above the start threshold before setting at 15V.

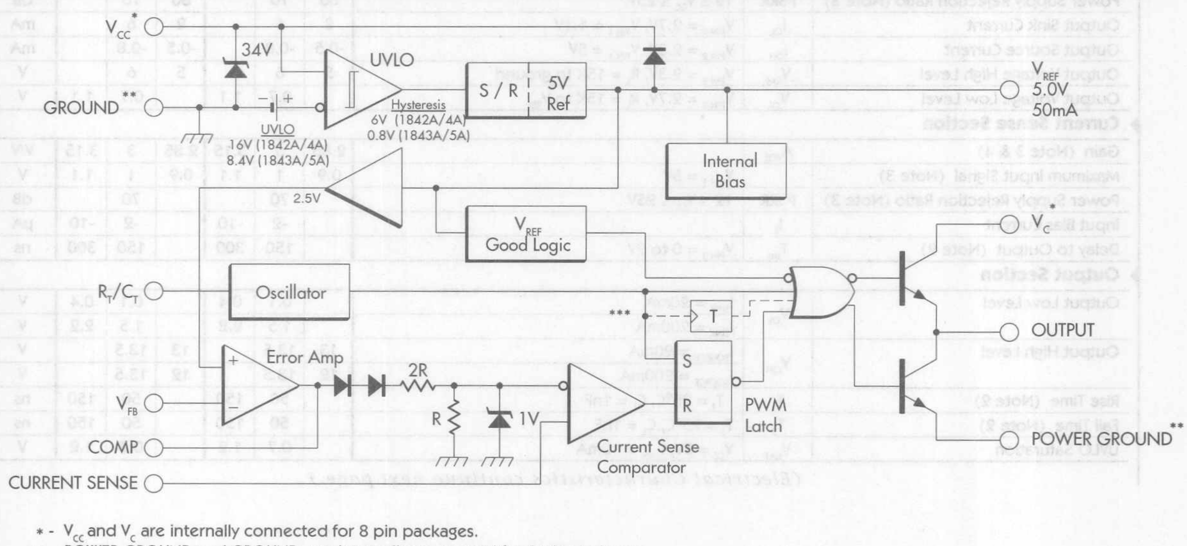
6. Output frequency equals oscillator frequency for the UC1842A and UC1843A. Output frequency is one half oscillator frequency for the UC1844A and UC1845A.

7. "Temperature stability, sometimes referred to as average temperature coefficient, is described by the equation:

$$\text{Temp Stability} = \frac{V_{REF}\,(\text{max.}) - V_{REF}\,(\text{min.})}{T_J\,(\text{max.}) - T_J\,(\text{min.})}$$

V_{REF} (max.) & V_{REF} (min.) are the maximum & minimum reference voltage measured over the appropriate temperature range. Note that the extremes in voltage do not necessarily occur at the extremes in temperature."

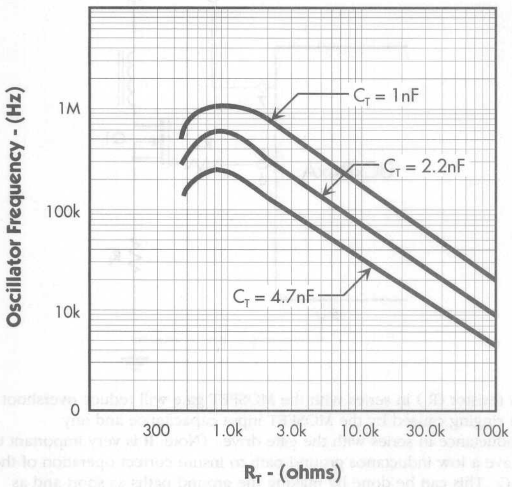
BLOCK DIAGRAM

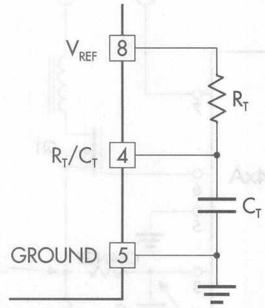


* - V_{CC} and V_C are internally connected for 8 pin packages.
** - POWER GROUND and GROUND are internally connected for 8 pin packages.
*** - Toggle flip flop used only in x844A and x845A series.

CHARACTERISTIC CURVES

FIGURE 1. — OSCILLATOR FREQUENCY vs. TIMING RESISTOR

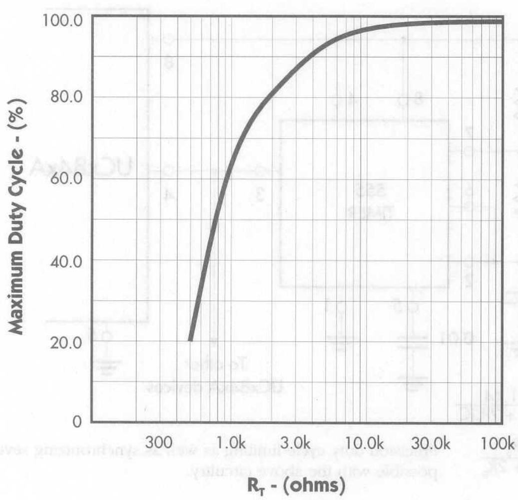




For $R_T > 5k$, $f \approx \frac{1.72}{R_T\,C_T}$

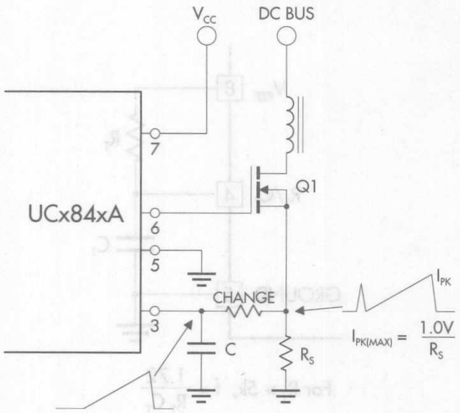
Note: Output drive frequency is half the oscillator frequency for the UCx844A/5A devices.

FIGURE 2. — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR



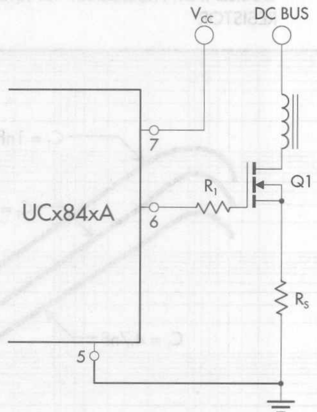
TYPICAL APPLICATION CIRCUITS

FIGURE 3. — CURRENT SENSE SPIKE SUPPRESSION



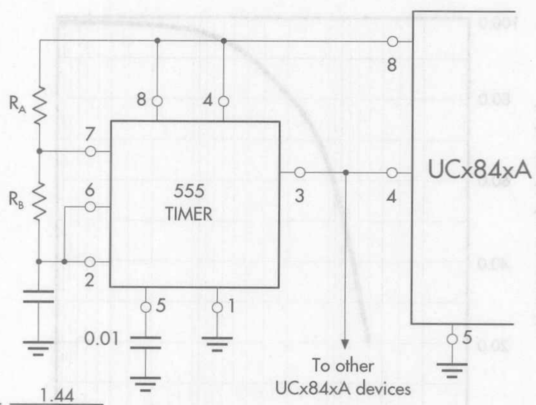
The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

FIGURE 4. — MOSFET PARASITIC OSCILLATIONS



A resistor (R_1) in series with the MOSFET gate will reduce overshoot & ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

FIGURE 5. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION



$$f = \frac{1.44}{(R_A + 2R_B)C}$$

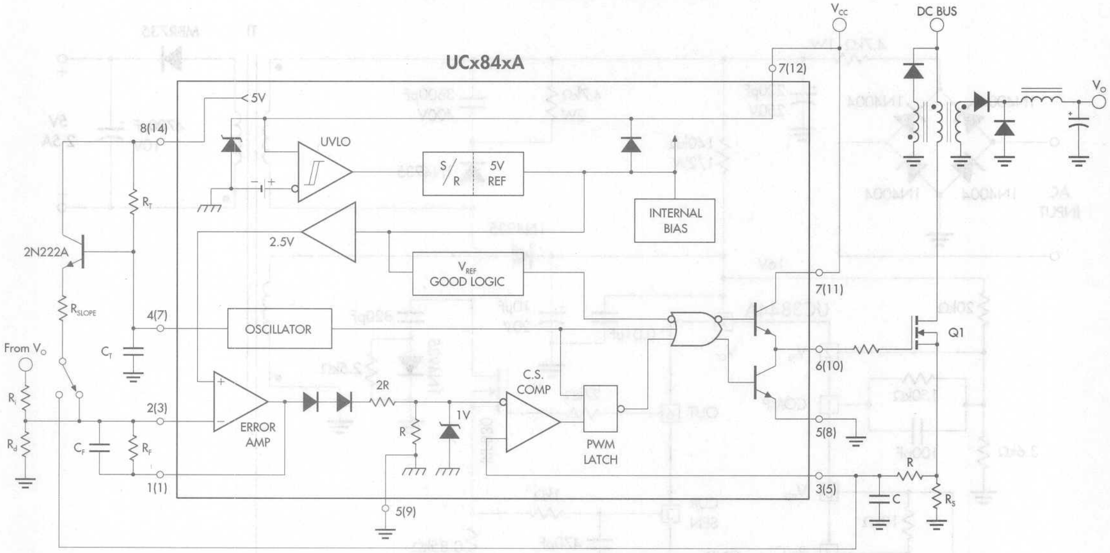
$$f = \frac{R_B}{R_A + 2R_B}$$

Precision duty cycle limiting as well as synchronizing several parts is possible with the above circuitry.

LINFINITY MICROELECTRONICS

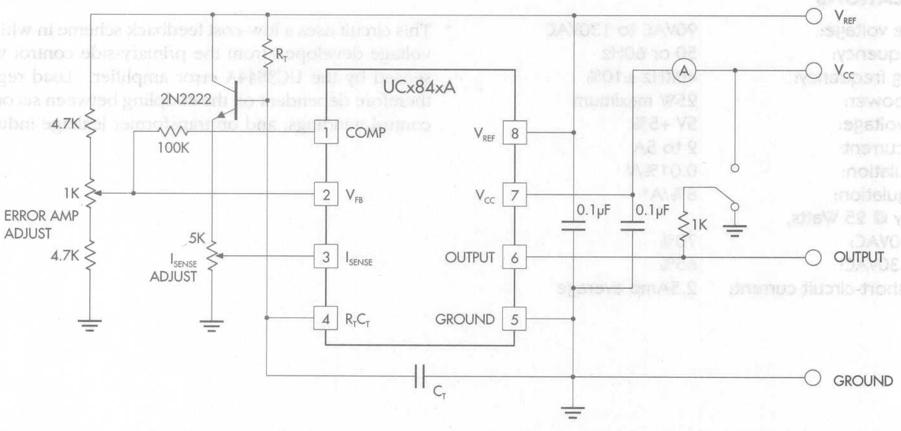
TYPICAL APPLICATION CIRCUITS (continued)

FIGURE 6. — SLOPE COMPENSATION



Due to inherent instability of current mode converters running above 50% duty cycle, slope compensation should be added to either the current sense pin or the error amplifier. Figure 6 shows a typical slope compensation technique.

FIGURE 7. — OPEN LOOP LABORATORY FIXTURE

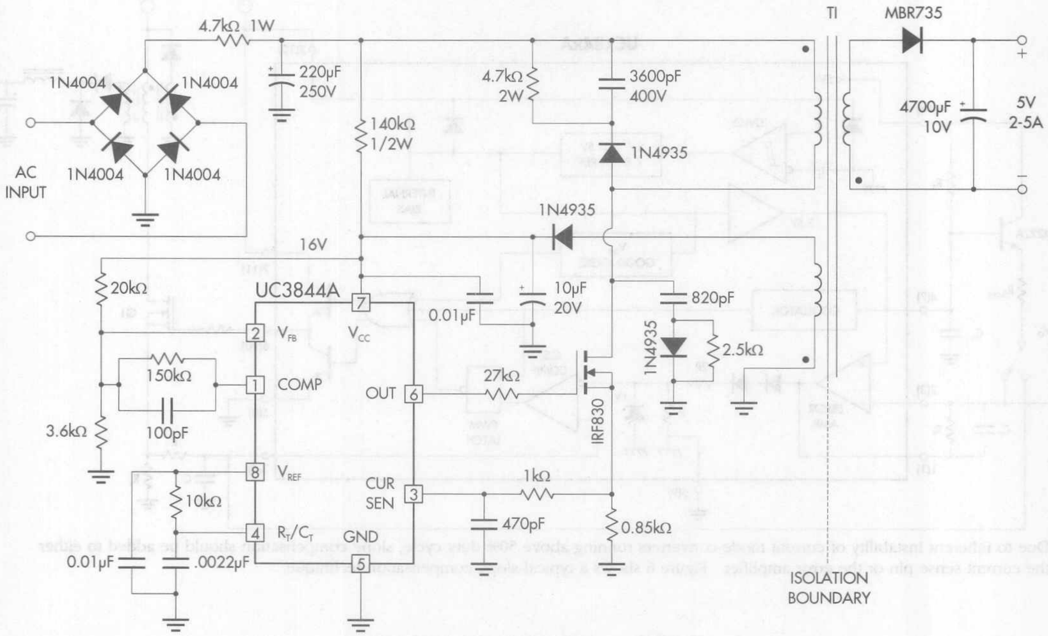


High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.

LINFINITY MICROELECTRONICS

TYPICAL APPLICATION CIRCUITS (continued)

FIGURE 8. — OFF-LINE FLYBACK REGULATOR



SPECIFICATIONS

Input line voltage:	90VAC to 130VAC
Input frequency:	50 or 60Hz
Switching frequency:	40KHz ±10%
Output power:	25W maximum
Output voltage:	5V +5%
Output current:	2 to 5A
Line regulation:	0.01%/V
Load regulation:	8%/A*
Efficiency @ 25 Watts,	
V_{IN} = 90VAC:	70%
V_{IN} = 130VAC:	65%
Output short-circuit current:	2.5Amp average

* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the UC3844A error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.

LINFINITY MICROELECTRONICS

Thumb Index

LINFINITY MICROELECTRONICS

Section Index

DATA COMMUNICATIONS PRODUCTS

SCSI Terminators

SCSI Transceivers

Bold = New Product, ****Bold Italic*** = Preliminary

LINFINITY MICROELECTRONICS

Data Communications Products

SCSI Terminators

Performance Characteristics

Device Type	Page #	SCSI Standard 2	SCSI Standard 3	SCSI Standard ULTRA	No. of Channels	Output Capacitance	Active Neg. Compatible	Hot Swap	Supply Current	Logic Enable	Packages
LX5212	7-31			✓	9	2.5pF	Y	Y	600µA	L	N, PWP DP
LX5218	7-39			✓	9	4.0pF	Y	N	6.0mA	L	DW, PW
LX5219	7-39			✓	9	4.0pF	Y	N	6.0mA	H	DW, PW
LX5207	7-23			✓	18	2.5pF	Y	Y	800µA	L	N, DWP
LX5204	7-19	✓	✓		9	3.5pF	Y	y	600µA	L	PWP, DP
LX5107	7-5	✓	✓		9	3pF	Y	Y	700µA	H	DW, PW
LX5203	7-15	✓	✓		9	6pF	Y	N	600µA	L	N, DP
LX5213	7-35	✓	✓		9	3.5pF	Y	N	600µA	L	N, PWP DP
LX5202	7-11	✓	✓		18	6pF	Y	N	800µA	L	N, DWP
LX5208	7-27	✓	✓		18	3.5pF	Y	N	800µA	L	N, DWP
LX5285	6-81	✓	✓	✓	n/a	n/a	Y	n/a	5.0mA	n/a	ST

SCSI Transceivers

Performance Characteristics

Device Type	Page #	SCSI Standard	# Channels Receiver	# Channels Driver	Logic	Output Capacitance	Output Configuration	Prop. Delay Driver	Prop. Delay Receiver	Packages
LX5268	7-51	2, 3, ULTRA	6	6	Invert.	15pF	Totem-Pole Open-Drain	10ns	10ns	DB
LX5269	7-59	2, 3, ULTRA	6	6	Buffer	15pF	Totem-Pole Open-Drain	10ns	10ns	DB

LINFINITY MICROELECTRONICS

Notes

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX5107

9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5107 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5107 requires a meager 30µA of supply current while offering only 3.0pF of output capacitance. To enter this low-power mode, the disconnect pin should be driven low thereby disconnecting the terminating resistors and placing the internal low drop-out regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error free communications.

During normal operation, the LX5107 consumes only 600µA of current which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low drop-out regulator architecture enables this unique and very efficient operating characteristic.

The LX5107 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. In addition, the LX5107 sinks up to 50mA of current making it compatible with today's fast active negation drivers.

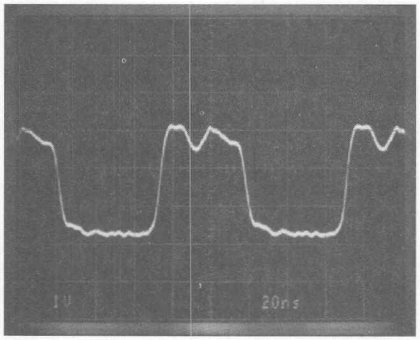
The LX5107 is a superior, pin-for-pin replacement for a variety of industry products such as the DS2107S and DS21S07A.

KEY FEATURES

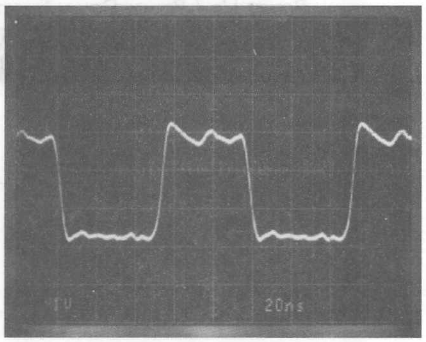
- 3.0pF OUTPUT CAPACITANCE DURING DISCONNECT
- 30µA SUPPLY CURRENT IN DISCONNECT MODE
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 50mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- MEETS SCSI HOT PLUGGING CAPABILITY
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5107TR**

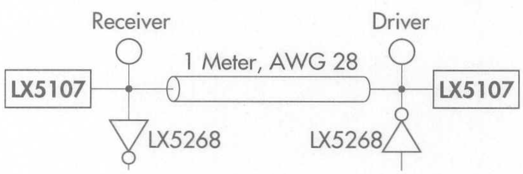
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_J (°C)	DW Plastic SOWB 16-pin	PWP Plastic TSSOP 20-pin, Power
0 to 125	LX5107CDW	LX5107CPWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5107CDWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX5107

9-Line Low Capacitance, μPower SCSI Terminator

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 0.5A
Operating Junction Temperature
Plastic (DW, PW Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

DW PACKAGE:

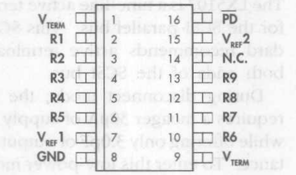
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

PWP PACKAGE:

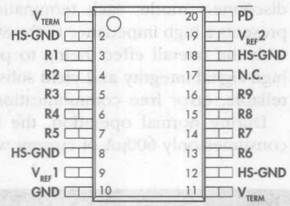
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	83°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



DW PACKAGE
(Top View)



PWP PACKAGE
(Top View)

Power Up / Power Down Function Table

Disconnect	Outputs	Quiescent Current
L	HI Z	30μA
H	Enabled	600μA
Open	Enabled	600μA

9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitor on V_{REF}		2.2			µF
Operating Virtual Junction Temperature Range					
LX5107C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \leq T_A \leq 70°C$. TermPwr = 4.75V, Disconnect = Open. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5107 Min.	Typ.	Max.	Units
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	210	mA
Power Down Mode		Disconnect = Low		30	70	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	105	110	115	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.6	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \leq T_A \leq 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \leq T_A \leq 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Low, V_{OUT} = 0V to 4.0V		10	400	nA
Output Capacitance		Disconnect = Low		3.0		pF
Sink Current		V_{OUT} = 4V	30	50		mA
Regulator Section						
Regulator Output Voltage	V_{REF}			3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -50mA		20	50	mV
Drop Out Voltage		I_{REG} = -50mA		0.7	1.0	V
Short Circuit Current		V_{REG} = 0V		-425	-600	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8	1.4	2.0	V
Input Current		Disconnect = 0V			65	µA

LX5107

9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

FIGURE INDEX

Application Circuits

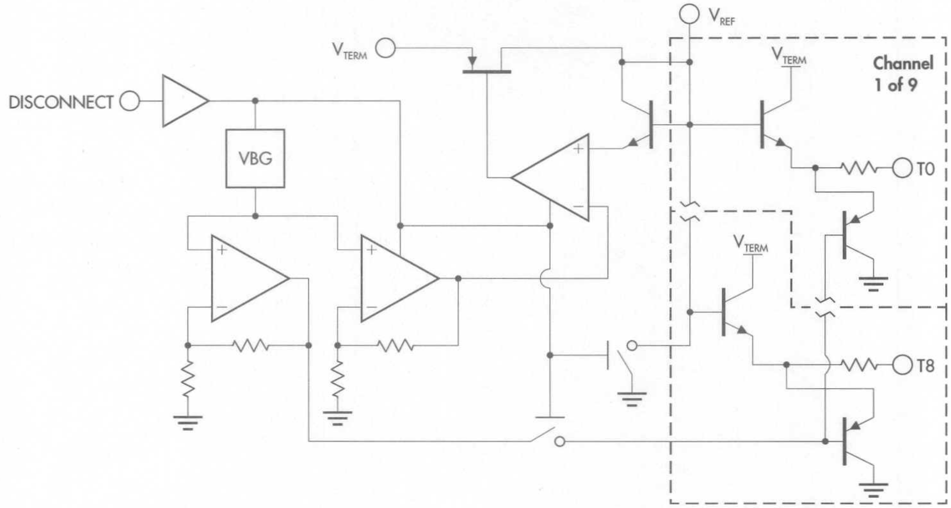
GRAPH / CURVE INDEX

Characteristic Curves

LINFINITY MICROELECTRONICS

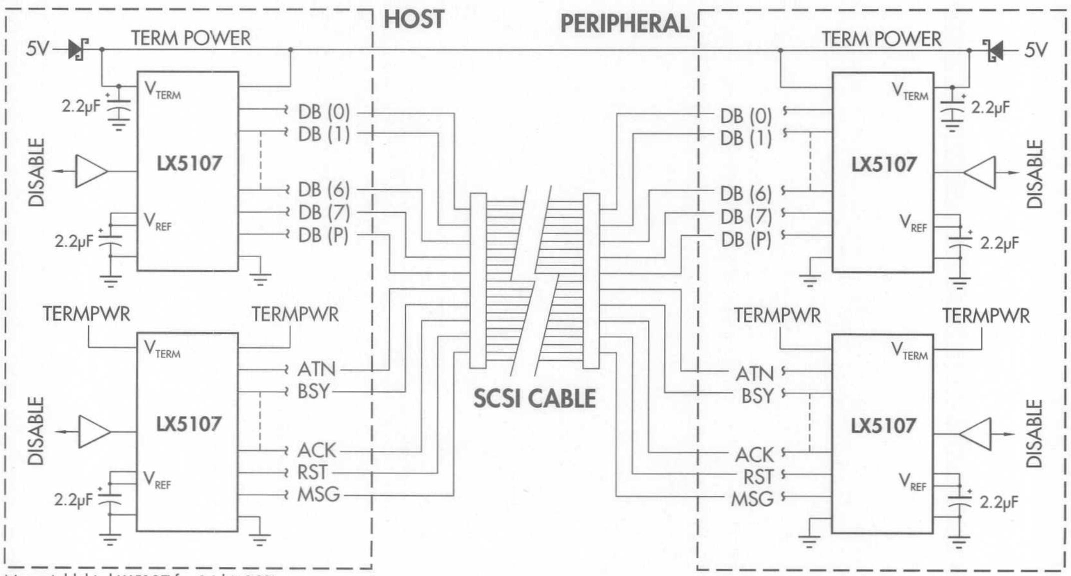
BLOCK DIAGRAM

FIGURE 1 — LX5107 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5107 for 16-bit SCSI

Notes

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX5202

18-LINE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5202 is an eighteen-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5202 requires a meager 60µA of supply current while offering only 6pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5202 consumes only 800µA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5202 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5202 sinks up to 200mA of current making it compatible with today's fast active negation drivers.

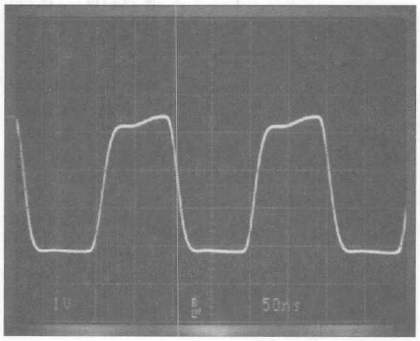
The LX5202 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601 and UC5602.

KEY FEATURES

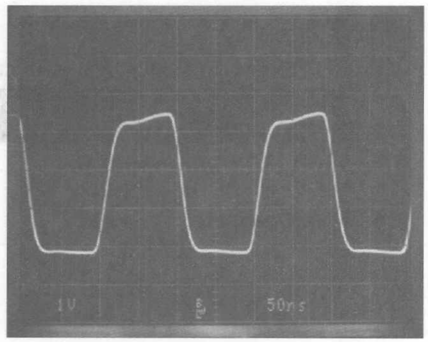
- 6pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60µA SUPPLY CURRENT IN DISCONNECT MODE
- 800µA SUPPLY CURRENT DURING NORMAL OPERATION
- 200mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5202TR**

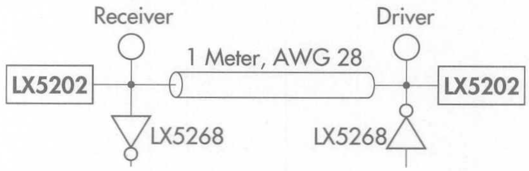
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 5MHz



DRIVING WAVEFORM - 5MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	SAMPLING ONLY N Plastic DIP 24-pin	DWP Plastic SOWB 28-pin, Power
0 to 70	LX5202CN	LX5202CDWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5202CDWPT)

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX5202

18-LINE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 1.2A
Operating Junction Temperature
  Plastic (N, DWP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

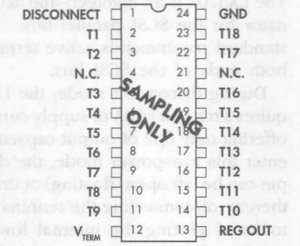
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	52°C/W

DWP PACKAGE:

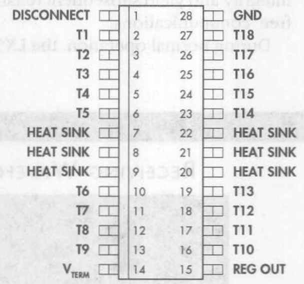
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	40°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



N PACKAGE
(Top View)



DWP PACKAGE
(Top View)

POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	800μA
H	HI Z	60μA
Open	HI Z	60μA

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitance on REGOUT		4.7			µF
Operating Virtual Junction Temperature Range					
LX5202C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

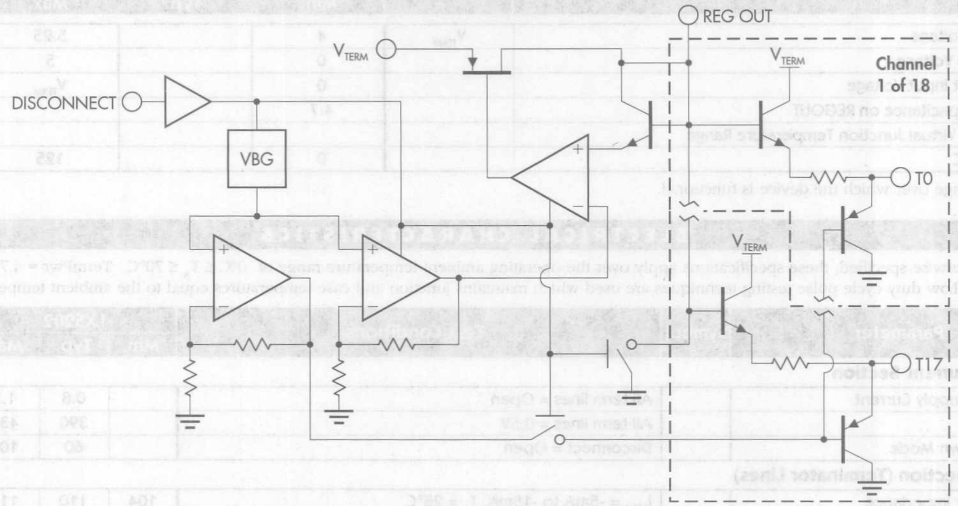
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \leq T_A \leq 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5202			Units
			Min.	Typ.	Max.	
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.8	1.5	mA
		All term lines = 0.5V		390	430	mA
Power Down Mode		Disconnect = Open		60	100	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \leq T_A \leq 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \leq T_A \leq 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		6		pF
Sink Current		V_{OUT} = 4V	100	200		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -100mA		20	50	mV
Drop Out Voltage		I_{REG} = -100mA		0.45	1.0	V
Short Circuit Current		V_{REG} = 0V		-700	-1000	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

LINFINITY MICROELECTRONICS

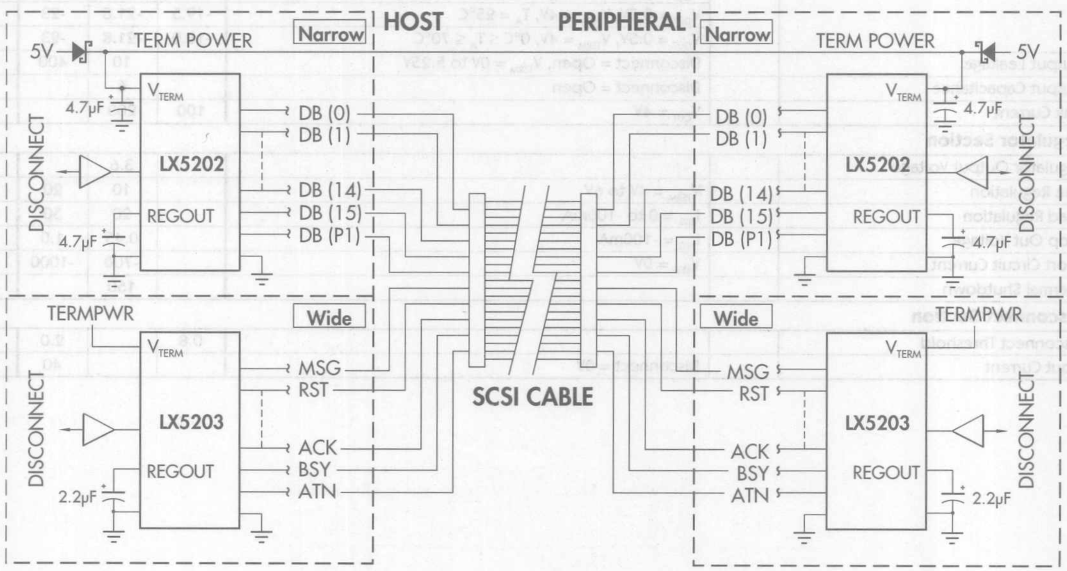
BLOCK DIAGRAM

FIGURE 1 — LX5202 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8/16-BIT SCSI SYSTEM APPLICATION



LINFINITY MICROELECTRONICS

LX5203

9-LINE SCSI ACTIVE TERMINATOR

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

DESCRIPTION

The LX5203 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5203 requires a meager 60μA of supply current, while offering only 6pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5203 consumes only 600μA of current. Linfinity's proprietary BiCMOS low dropout regulator architecture enables oscillation-free operation with minimal output capacitance. Linfinity recommends a minimum stabilization capacitor value of 2.2μF.

The LX5203 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5203 sinks up to 150mA of current making it compatible with today's fast active negation drivers.

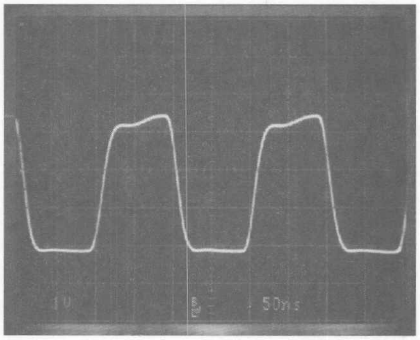
The LX5203 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

KEY FEATURES

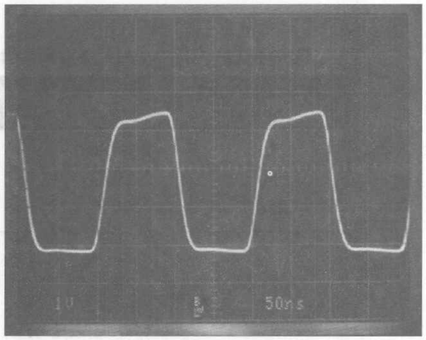
- 6pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60μA SUPPLY CURRENT IN DISCONNECT MODE
- 600μA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5203TR**

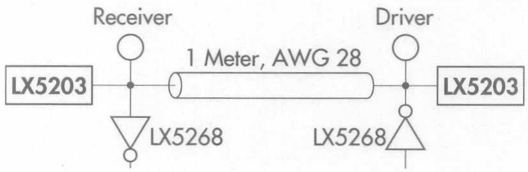
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 5MHz



DRIVING WAVEFORM - 5MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	DP Plastic SOIC 16-pin, Power
0 to 70	LX5203CN	LX5203CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5203CDPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Rev. 1.6 6/96

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 0.4A
Operating Junction Temperature
  Plastic (N, DP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

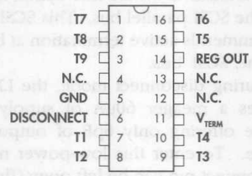
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

DP PACKAGE:

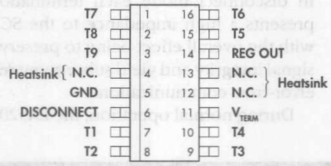
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	45°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



N PACKAGE
(Top View)



DP PACKAGE
(Top View)

POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	600µA
H	HI Z	60µA
Open	HI Z	60µA

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitor on REGOUT		2.2			µF
Operating Virtual Junction Temperature Range					
LX5203C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \le T_A \le 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5203 Min.	Typ.	Max.	Units
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	208	mA
Power Down Mode		Disconnect = Open		60	100	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \le T_A \le 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \le T_A \le 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		6		pF
Sink Current		V_{OUT} = 4V	100	150		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -50mA		20	50	mV
Drop Out Voltage		I_{REG} = -50mA		0.7	1.0	V
Short Circuit Current		V_{REG} = 0V		-200	-350	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

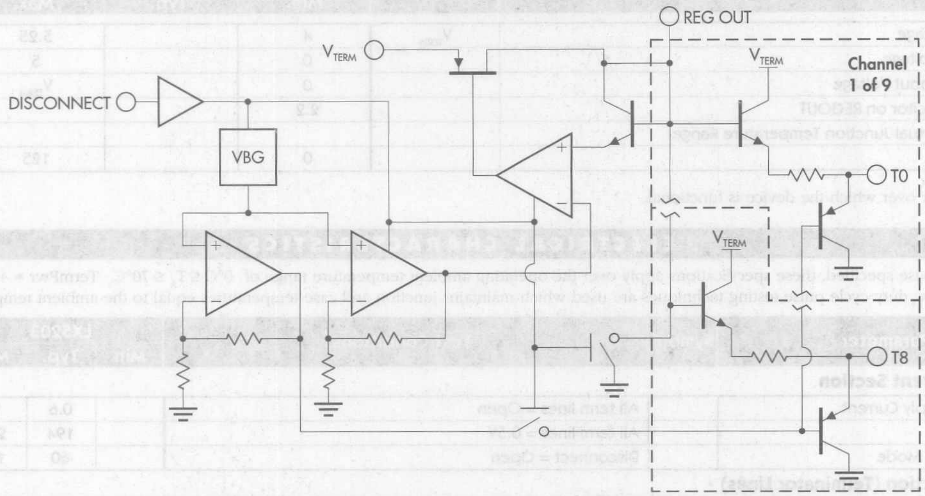
LINFINITY MICROELECTRONICS

9-LINE SCSI ACTIVE TERMINATOR

PRODUCTION DATA SHEET

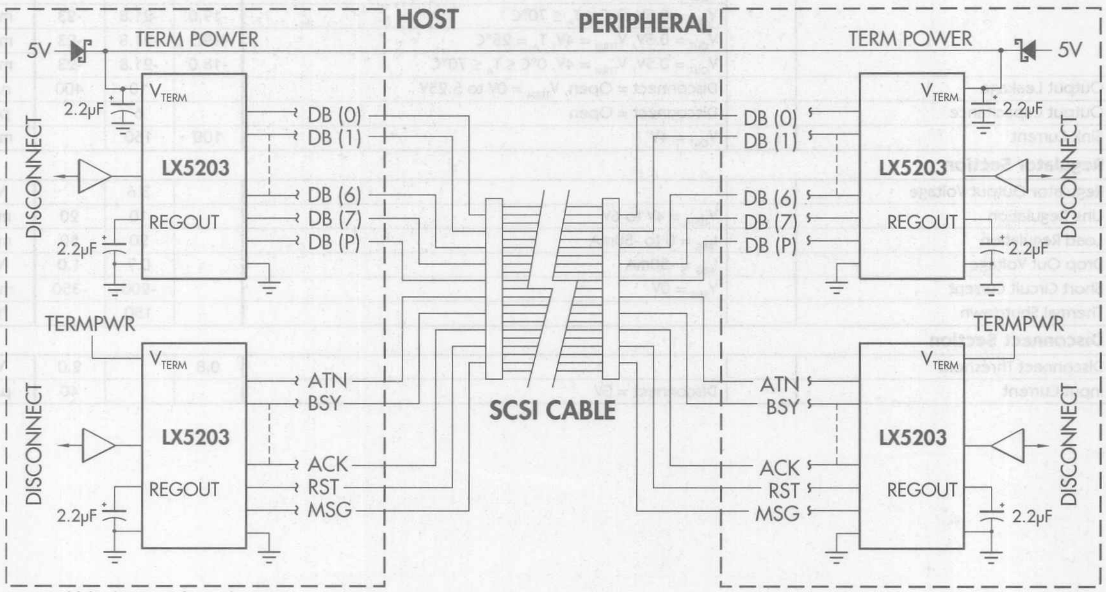
BLOCK DIAGRAM

FIGURE 1 — LX5203 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5203 for 16-bit SCSI

Rev. 1.6 6/96

LINFINITY
MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX5204

9-LINE HOT SWAP, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5204 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus. The LX5204 has the added features of hot swappability, fully complying with the SCSI hot swap specification.

During disconnect mode, the LX5204 requires a meager 60μA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high-signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5204 consumes only 600μA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5204 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5204 sinks up to 150mA of current, making it compatible with today's fast active negation drivers.

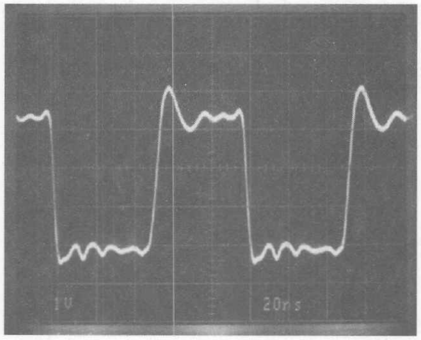
The LX5204 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

KEY FEATURES

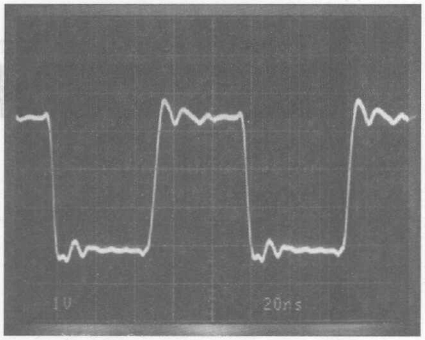
- 3.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- HOT SWAP COMPATIBLE
- 60μA SUPPLY CURRENT IN DISCONNECT MODE
- 600μA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5204TR**

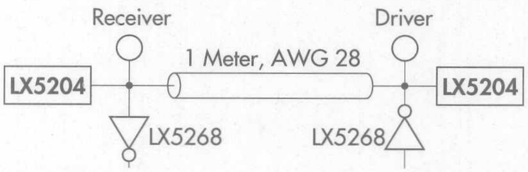
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	PWP Plastic TSSOP 24-pin, Power	DP Plastic SOIC 16-pin, Power
0 to 70	LX5204CPWP	LX5204CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5204CDPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX5204

9-LINE HOT SWAP, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage ..... +7V
Signal Line Voltage ..... 0V to +7V
Regulator Output Current 0.4A
Operating Junction Temperature
Plastic (PWP, DP Packages) ..... 150°C
Storage Temperature Range ..... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) ..... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

PWP PACKAGE:

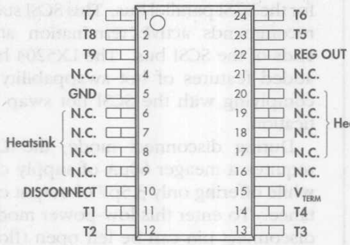
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	27°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

DP PACKAGE:

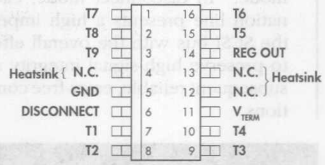
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	45°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



PWP PACKAGE
(Top View)



DP PACKAGE
(Top View)

POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	600μA
H	HI Z	60μA
Open	HI Z	60μA

LINFINITY
MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitor on REGOUT		2.2			µF
Operating Virtual Junction Temperature Range					
LX5204C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \leq T_A \leq 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

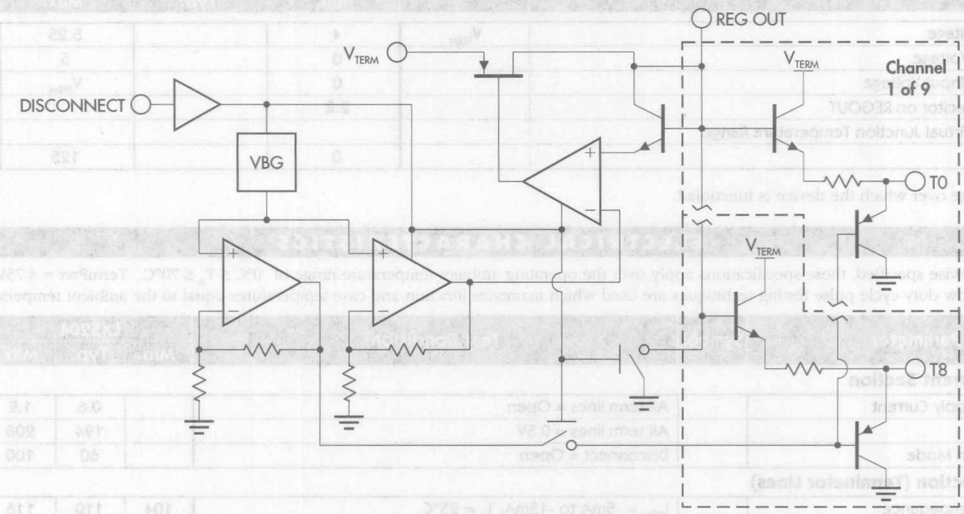
Parameter	Symbol	Test Conditions	LX5204			Units
			Min.	Typ.	Max.	
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	208	mA
Power Down Mode		Disconnect = Open		60	100	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \leq T_A \leq 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \leq T_A \leq 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		3.5		pF
Sink Current		V_{OUT} = 4V	20	30		mA
Hot Swap			Fully Compliant			
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -50mA		20	50	mV
Drop Out Voltage		I_{REG} = -50mA		0.7	1.0	V
Short Circuit Current		V_{REG} = 0V		-200	-350	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

9-LINE HOT SWAP, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

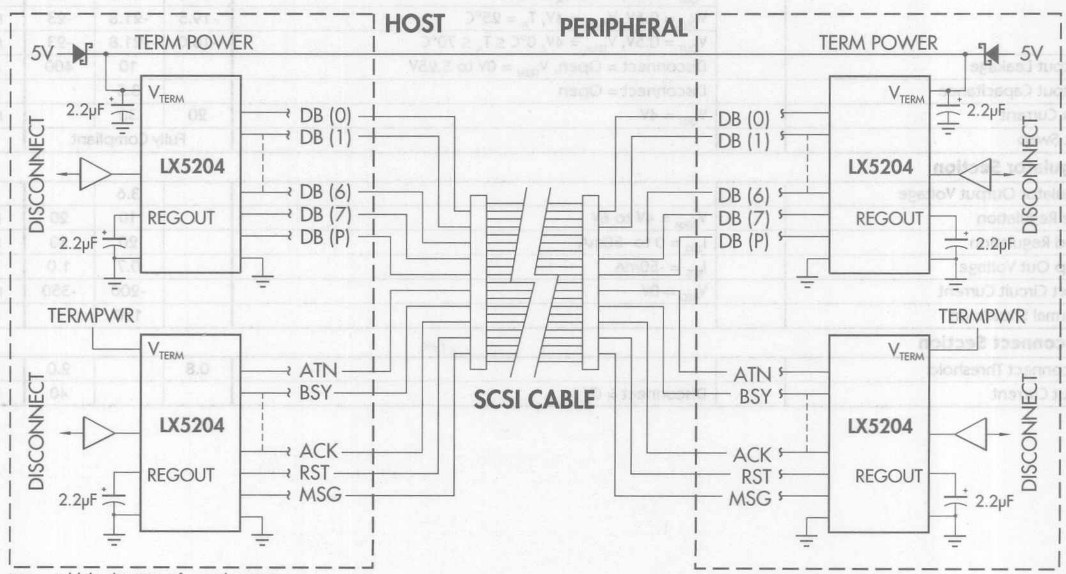
BLOCK DIAGRAM

FIGURE 1 — LX5204 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5204 for 16-bit SCSI

LINFINITY MICROELECTRONICS

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THE INFINITE POWER OF INNOVATION

LX5207

18-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5207 is an eighteen line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5207 requires a meager 500nA of supply current while offering only 2.5pF of output capacitance. To enter this low power mode, the disconnect pin can be left open (floating) or driven high thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low power mode. In disconnect mode each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and subsequent reliable, error free communications.

During normal operation, the LX5207 consumes only 800µA of current which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5207 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And finally, the LX5207 sinks up to 100mA of current making it compatible with today's fast active negation drivers.

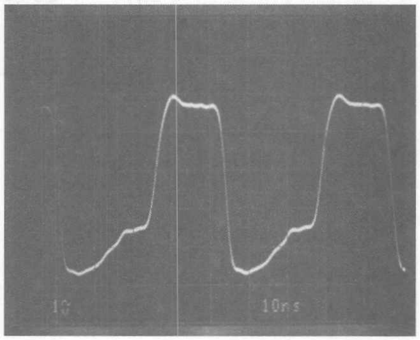
The LX5207 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601, UC5602, UC5608, and UC5609.

KEY FEATURES

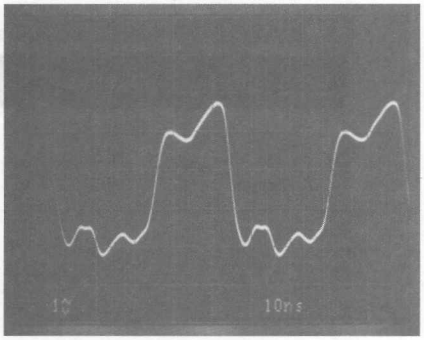
- 2.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- 500nA SUPPLY CURRENT IN DISCONNECT MODE
- 800µA SUPPLY CURRENT DURING NORMAL OPERATION
- 100mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2, 3, AND FAST-20 STANDARDS
- HOT SWAP COMPATIBLE
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5207TR**

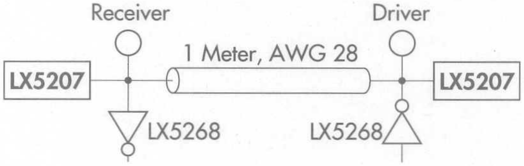
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 20MHz



DRIVING WAVEFORM - 20MHz





— NOTE: —
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 24-pin	DWP Plastic SOWB 28-pin, Power
0 to 70	LX5207CN	LX5207CDWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5207CDWPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX5207

18-Line Low Capacitance, µPower SCSI Terminator

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 1.2A
Operating Junction Temperature
  Plastic (N, DWP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

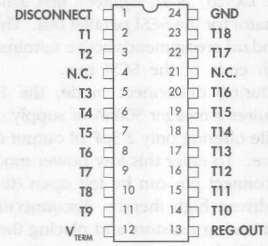
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	52°C/W

DWP PACKAGE:

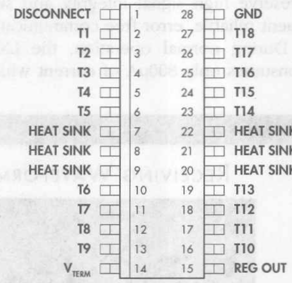
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	40°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



N PACKAGE
(Top View)



DWP PACKAGE
(Top View)

Power Up / Power Down Function Table

Disconnect	Outputs	Quiescent Current
L	Enabled	800µA
H	HI Z	0.5µA
Open	HI Z	0.5µA

LINFINITY MICROELECTRONICS

18-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Termpwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitance on REGOUT		4.7			μF
Operating Virtual Junction Temperature Range					
LX5207C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \le T_A \le 70°C$. Termpwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5207 Min.	Typ.	Max.	Units
Supply Current Section						
Termpwr Supply Current		All term lines = Open		0.8	1.5	mA
		All term lines = 0.5V		390	415	mA
Power Down Mode		Disconnect = Open		0.5	1	μA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \le T_A \le 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \le T_A \le 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		2.5		pF
Sink Current		V_{OUT} = 4V	70	100		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -100mA		20	50	mV
Drop Out Voltage		I_{REG} = -100mA		0.45	1.0	V
Short Circuit Current		V_{REG} = 0V		-800	-1100	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	μA

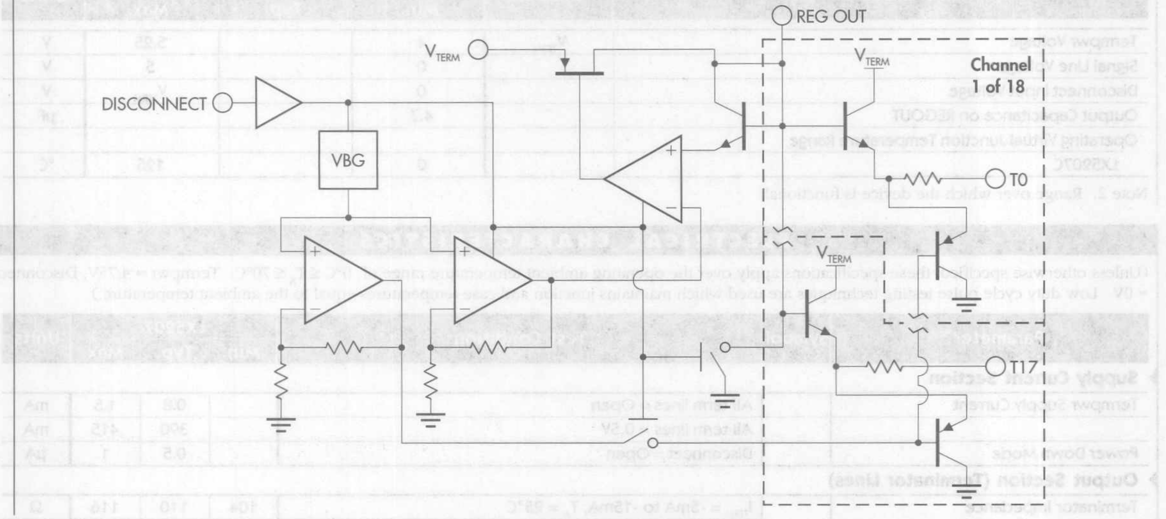
LINFINITY MICROELECTRONICS

18-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

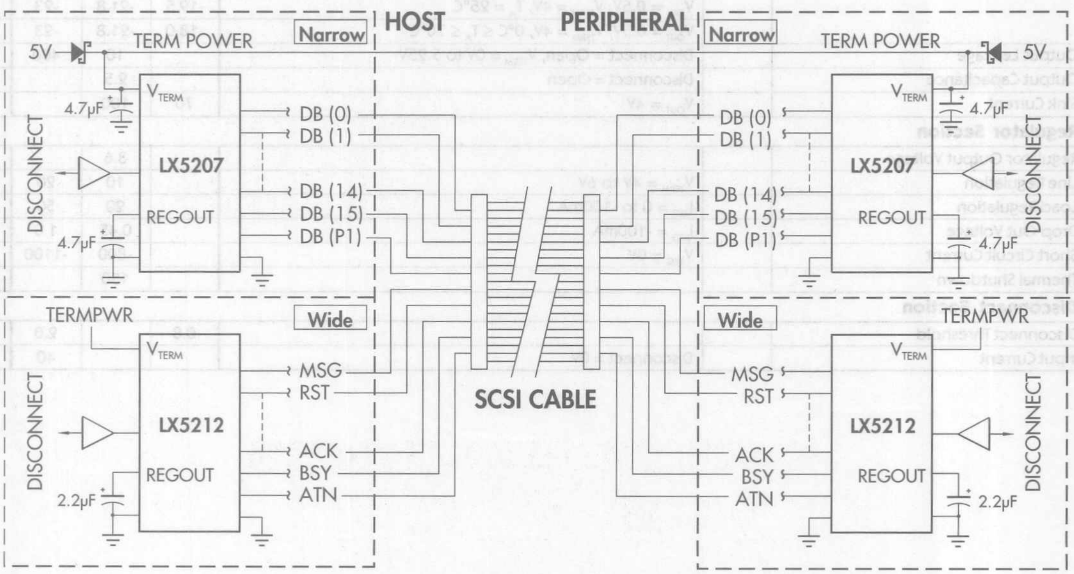
BLOCK DIAGRAM

FIGURE 1 — LX5207 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8/16-BIT SCSI SYSTEM APPLICATION



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LX5208

18-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5208 is an eighteen-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5208 requires a meager 60μA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error free communications.

During normal operation, the LX5208 consumes only 800μA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5208 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5208 sinks up to 200mA of current making it compatible with today's fast active negation drivers.

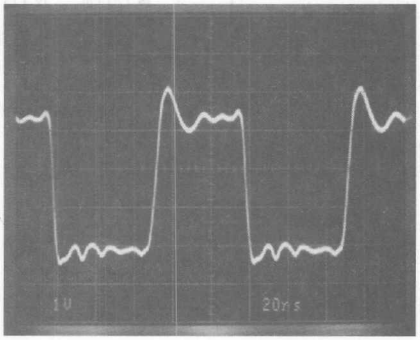
The LX5208 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601, UC5602, UC5608, and UC5609.

KEY FEATURES

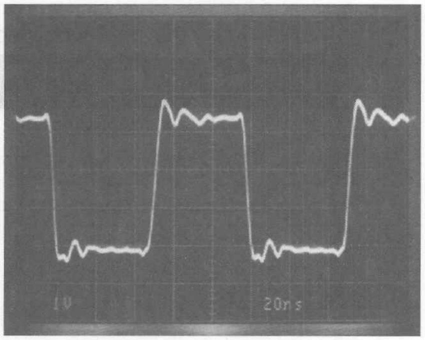
- 3.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60μA SUPPLY CURRENT IN DISCONNECT MODE
- 800μA SUPPLY CURRENT DURING NORMAL OPERATION
- 200mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5208TR**

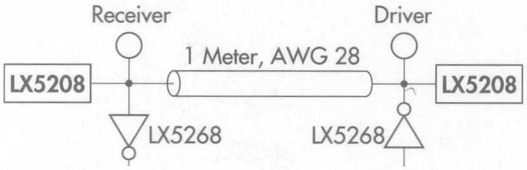
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 24-pin (SAMPLING ONLY)	DWP Plastic SOWB 28-pin, Power
0 to 70	LX5208CN	LX5208CDWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5208CDWPT)

LX5208

18-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 1.2A
Operating Junction Temperature
Plastic (N, DWP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	52°C/W

DWP PACKAGE:

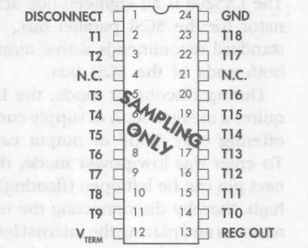
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	40°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

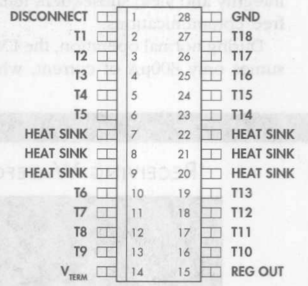
POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	800μA
H	HI Z	60μA
Open	HI Z	60μA

PACKAGE PIN OUTS



N PACKAGE
(Top View)



DWP PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitance on REGOUT		4.7			µF
Operating Virtual Junction Temperature Range					
LX5208C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \le T_A \le 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

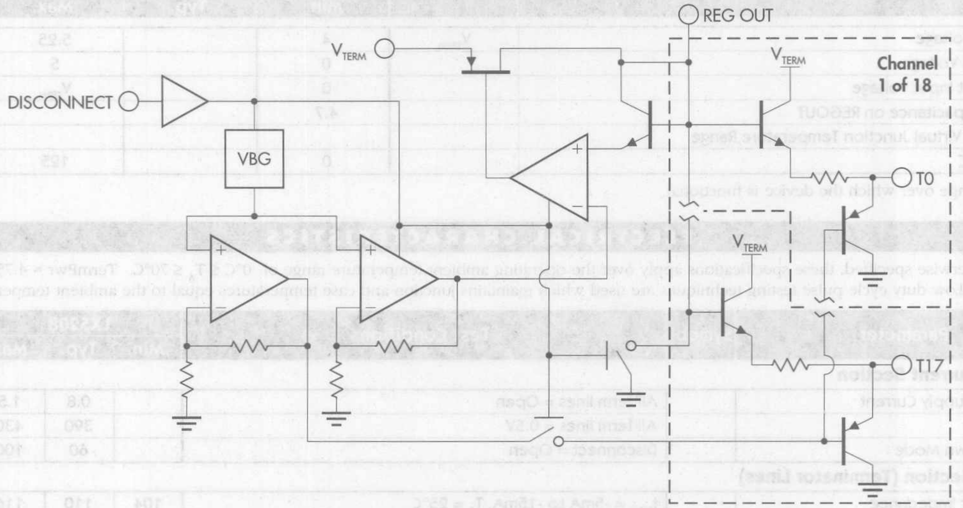
Parameter	Symbol	Test Conditions	LX5208			Units
			Min.	Typ.	Max.	
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.8	1.5	mA
		All term lines = 0.5V		390	430	mA
Power Down Mode		Disconnect = Open		60	100	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \le T_A \le 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \le T_A \le 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		3.5		pF
Sink Current		V_{OUT} = 4V	100	200		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -100mA		20	50	mV
Drop Out Voltage		I_{REG} = -100mA		0.45	1.0	V
Short Circuit Current		V_{REG} = 0V		-700	-1000	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

18-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

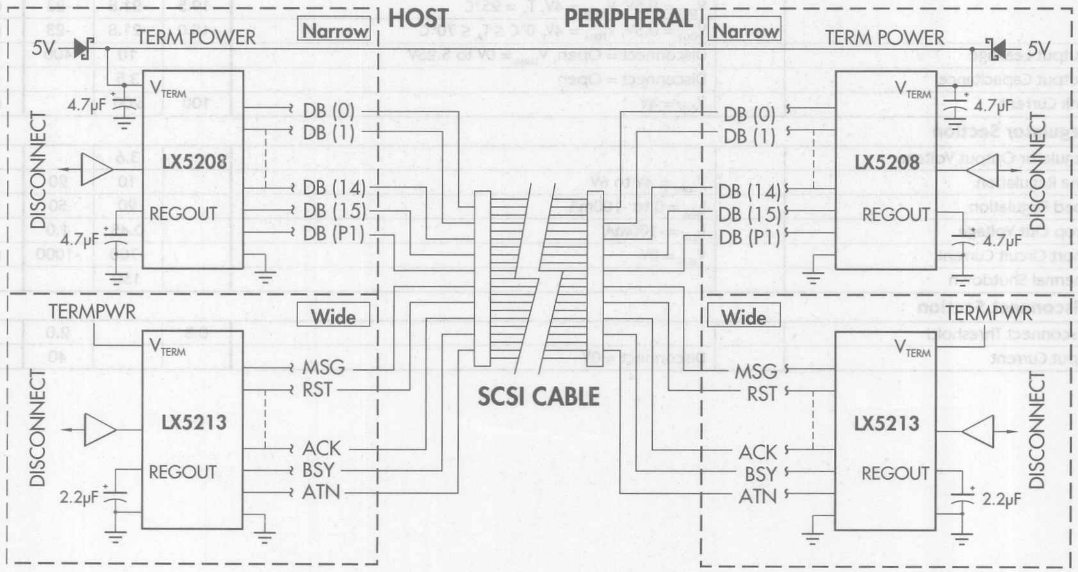
BLOCK DIAGRAM

FIGURE 1 — LX5208 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8/16-BIT SCSI SYSTEM APPLICATION



LINFINITY MICROELECTRONICS

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX5212

9-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5212 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5212 requires a meager 500nA of supply current while offering only 2.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5212 consumes only 600μA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5212 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5212 sinks up to 30mA of current, making it compatible with today's fast active negation drivers.

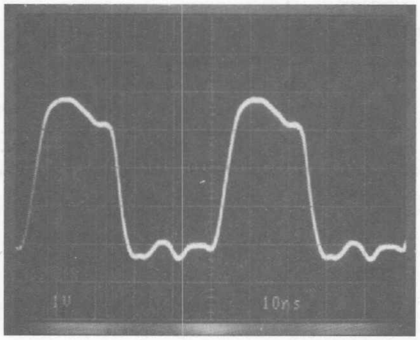
The LX5212 is a superior, pin-for-pin replacement for a variety of industry products, such as the UC5614.

KEY FEATURES

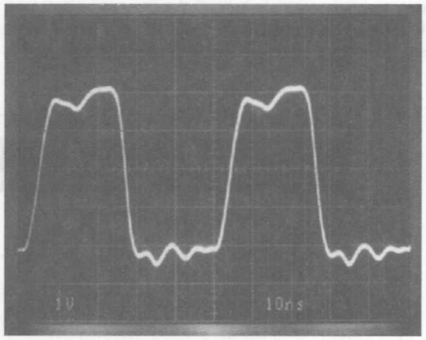
- 2.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- 500nA SUPPLY CURRENT IN DISCONNECT MODE
- 600μA SUPPLY CURRENT DURING NORMAL OPERATION
- 30mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2, 3, AND FAST 20 STANDARDS
- HOT SWAP COMPATIBLE
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5212TR**
- **EVALUATION BOARD AVAILABLE**

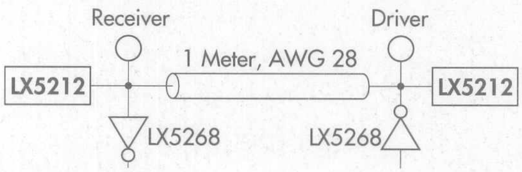
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 20MHz



DRIVING WAVEFORM - 20MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	PWP Plastic TSSOP 24-pin, Power	DP Plastic SOIC 16-pin, Power
0 to 70	LX5212CN	LX5212CPWP	LX5212CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5212CDPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX5212

9-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 0.4A
Operating Junction Temperature
  Plastic (N, PWP, DP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

PWP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	27°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	100°C/W

DP PACKAGE:

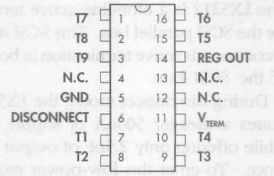
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	50°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

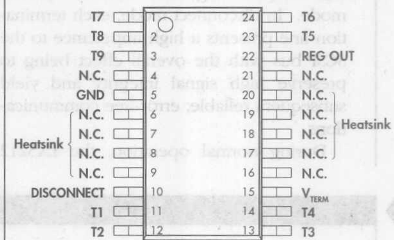
POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	600μA
H	HI Z	0.5μA
Open	HI Z	0.5μA

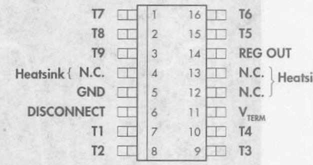
PACKAGE PIN OUTS



N PACKAGE
(Top View)



PWP PACKAGE
(Top View)



DP PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitor on REGOUT		2.2			µF
Operating Virtual Junction Temperature Range					
LX5212C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \leq T_A \leq 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5212 Min.	Typ.	Max.	Units
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	210	mA
Power Down Mode		Disconnect = Open		0.5	1	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \leq T_A \leq 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \leq T_A \leq 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		2.5		pF
Sink Current		V_{OUT} = 4V	20	30		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -50mA		20	50	mV
Drop Out Voltage		I_{REG} = -50mA		0.7	1.0	V
Short Circuit Current		V_{REG} = 0V		-200	-350	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

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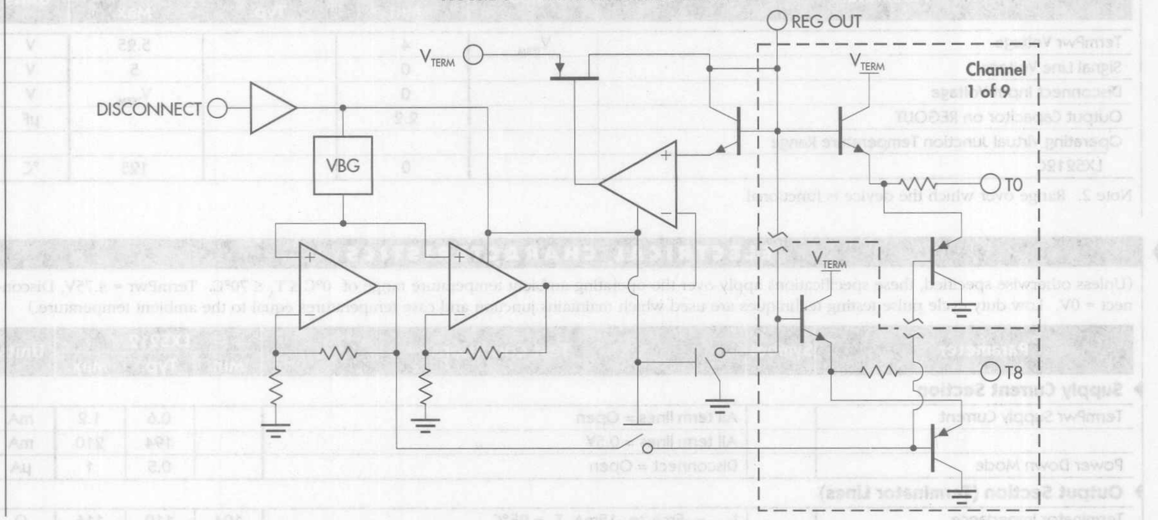
9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

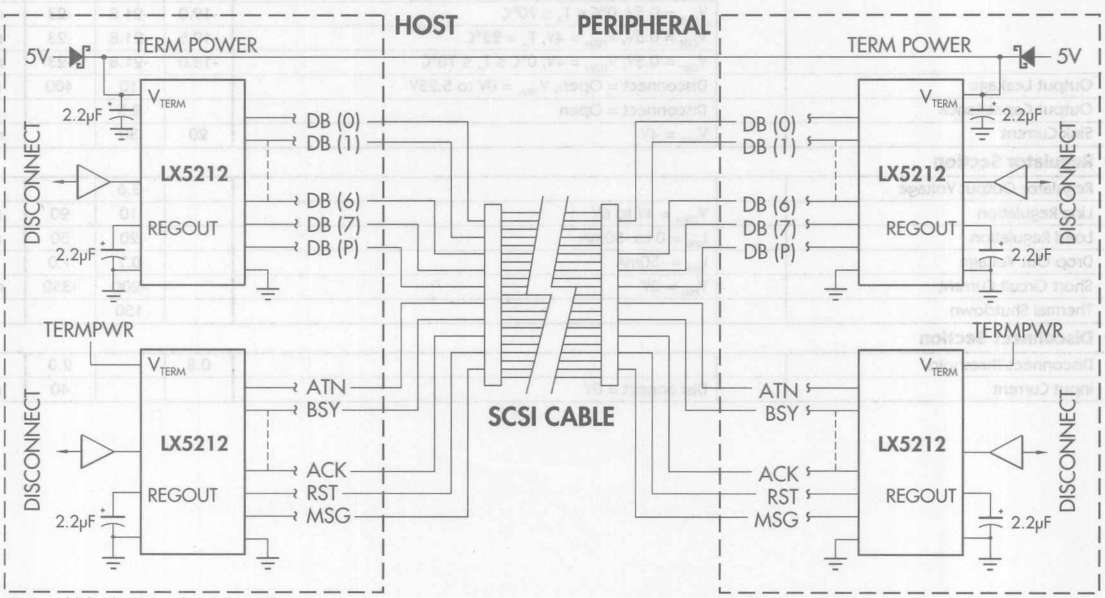
BLOCK DIAGRAM

FIGURE 1 — LX5212 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5212 for 16-bit SCSI

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LX5213

9-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

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DESCRIPTION

The LX5213 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5213 requires a meager 60μA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high-signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5213 consumes only 600μA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5213 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5213 sinks up to 150mA of current, making it compatible with today's fast active negation drivers.

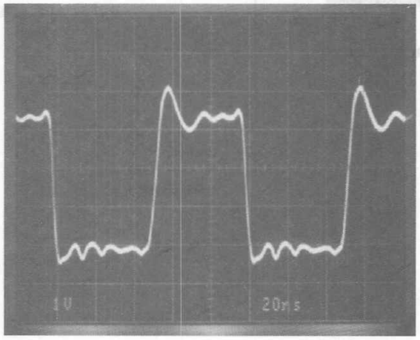
The LX5213 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

KEY FEATURES

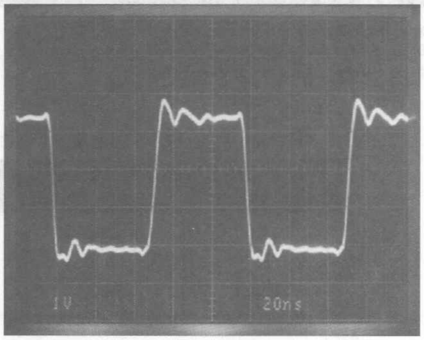
- 3.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60μA SUPPLY CURRENT IN DISCONNECT MODE
- 600μA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5213TR**

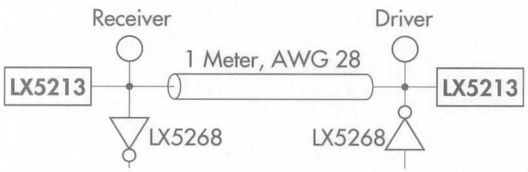
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHZ



DRIVING WAVEFORM - 10MHZ





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	PWP Plastic TSSOP 24-pin, Power	DP Plastic SOIC 16-pin, Power
0 to 70	LX5213CN	LX5213CPWP	LX5213CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5213CDPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage .... +7V
Signal Line Voltage .... 0V to +7V
Regulator Output Current 0.4A
Operating Junction Temperature
  Plastic (N, PWP, DP Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

THERMAL DATA

N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	65°C/W

PWP PACKAGE:

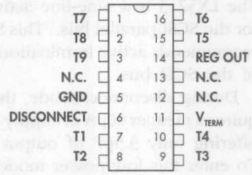
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	27°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	60°C/W

DP PACKAGE:

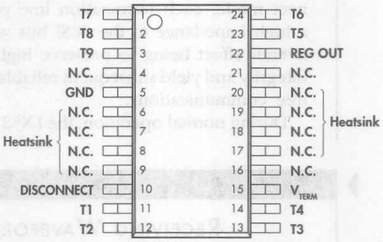
THERMAL RESISTANCE-JUNCTION TO LEADS, θ_{JL}	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	45°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

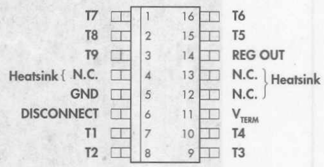
PACKAGE PIN OUTS



N PACKAGE
(Top View)



PWP PACKAGE
(Top View)



DP PACKAGE
(Top View)

POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	600µA
H	HI Z	60µA
Open	HI Z	60µA

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9-LINE LOW CAPACITANCE, µPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
TermPwr Voltage	V_{TERM}	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V_{TERM}	V
Output Capacitor on REGOUT		2.2			µF
Operating Virtual Junction Temperature Range					
LX5213C		0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of $0°C \leq T_A \leq 70°C$. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX5213 Min.	Typ.	Max.	Units
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	208	mA
Power Down Mode		Disconnect = Open		60	100	µA
Output Section (Terminator Lines)						
Terminator Impedance		I_{TERM} = -5mA to -15mA, T_A = 25°C	104	110	116	Ω
		I_{TERM} = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		V_{OUT} = 0.5V, T_A = 25°C	-20.3	-21.8	-23	mA
		V_{OUT} = 0.5V, $0°C \leq T_A \leq 70°C$	-19.0	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25°C	-19.5	-21.8	-23	mA
		V_{OUT} = 0.5V, V_{TERM} = 4V, $0°C \leq T_A \leq 70°C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V_{TERM} = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		3.5		pF
Sink Current		V_{OUT} = 4V	100	150		mA
Regulator Section						
Regulator Output Voltage				3.6		V
Line Regulation		V_{TERM} = 4V to 6V		10	20	mV
Load Regulation		I_{REG} = 0 to -50mA		20	50	mV
Drop Out Voltage		I_{REG} = -50mA		0.7	1.0	V
Short Circuit Current		V_{REG} = 0V		-200	-350	mA
Thermal Shutdown				150		°C
Disconnect Section						
Disconnect Threshold			0.8		2.0	V
Input Current		Disconnect = 0V			40	µA

LINFINITY MICROELECTRONICS

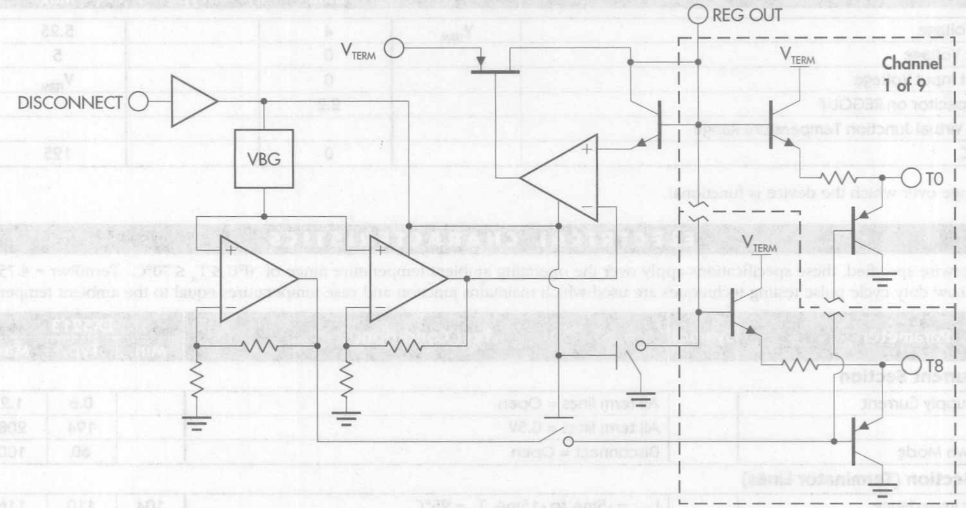
LX5213

9-LINE LOW CAPACITANCE, μPOWER SCSI TERMINATOR

PRODUCTION DATA SHEET

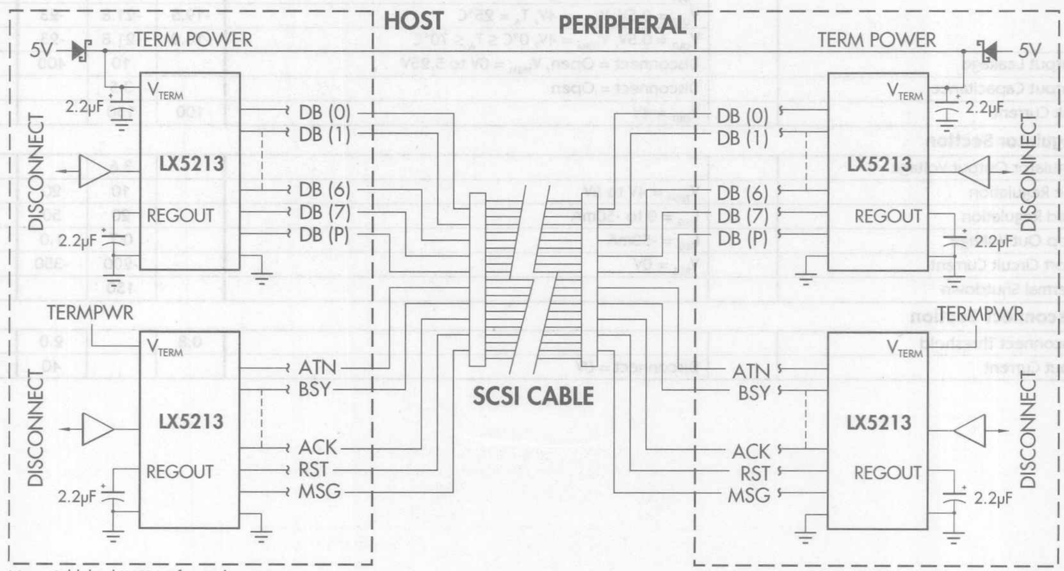
BLOCK DIAGRAM

FIGURE 1 — LX5213 BLOCK DIAGRAM



APPLICATION SCHEMATIC

FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5213 for 16-bit SCSI

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LIN Doc #: 5218

LX5218/LX5219

ULTRA 9-CHANNEL SCSI TERMINATOR

PRODUCTION DATA SHEET

DESCRIPTION

The LX5218 and LX5219 represent next-generation technology for SCSI termination applications. The low voltage BiCMOS architecture employed in their design offers superior performance to older passive and active techniques. The architecture employs high-speed adaptive elements for each channel, providing the fastest response possible. The channel bandwidth is typically 35MHz. The LX5218/19 compare favorably to older linear regulator approaches whose bandwidth's are dominated by the output compensation capacitor and are limited to the 500KHz bandwidth region (see further discussion in the Functional Description section). The new architechture also eliminates the output compensation capacitor typical in earlier terminator designs. Each is approved for use with SCSI 1, 2, 3, ULTRA and beyond — providing the highest performance alternative available today.

Another key improvement lies in their ability to insure reliable, error free communications even in systems which do not necessarily adhere to recommended SCSI hardware design guidelines, such as the use of improper cable lengths and impedances. Frequently, this situation is not controlled by the peripheral or host designer and, when problems occur, they are the first to be made aware of the problem. The LX5218/19 architecture is much more tolerant of marginal system integrations.

Recognizing the needs of portable and configurable peripherals, the LX5218/19 has a TTL compatible sleep/disable mode. Quiescent current is typically less than (275µA) in this mode, while the output capacitance is also less than 4pF. The obvious advantage of extended battery life for portable systems is inherent in the product's sleep mode feature. Additionally, the disable function permits factory floor or production-line configurability, reducing inventory and product-line diversity costs. Field configurability can also be accomplished without physically removing components which, oftentimes results in field returns due to mishandling.

Reduced component counts is also inherent in the LX5218/19 architecture. Traditional termination techniques require large stabilization and transient protection capacitors of up to 20µF in value and size. The LX5218/19 architecture does not require these components, allowing all the cost savings associated with inventory, board space, assembly, reliability, and component costs.

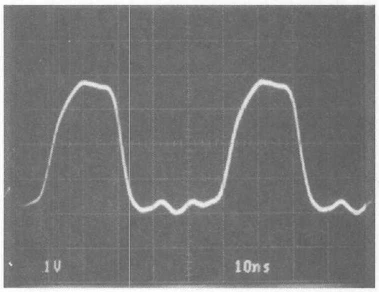
The difference between the LX5218 and the LX5219 is the sleep mode logic. The LX5218 is Active Low Logic. The LX5219 is Active High Logic.

KEY FEATURES

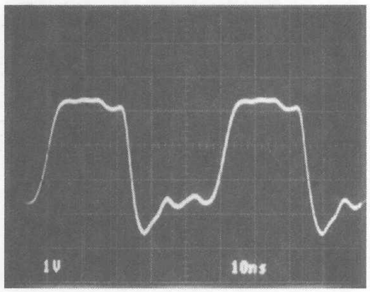
- ULTRA-FAST RESPONSE FOR FAST-20 SCSI APPLICATIONS
- 35MHz CHANNEL BANDWIDTH
- 3.5V OPERATION
- LESS THAN 4pF OUTPUT CAPACITANCE
- SLEEP MODE CURRENT LESS THAN 275µA
- THERMALLY SELF LIMITING
- NO EXTERNAL COMPENSATION CAPACITORS
- IMPLEMENTS 8-BIT OR 16-BIT (*WIDE*) APPLICATIONS
- COMPATIBLE WITH ACTIVE NEGATION DRIVERS (60mA / CHANNEL)
- COMPATIBLE WITH PASSIVE AND ACTIVE TERMINATIONS
- APPROVED FOR USE WITH SCSI 1, 2, 3 AND ULTRA
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5218TR**
- **EVALUATION BOARD AVAILABLE**

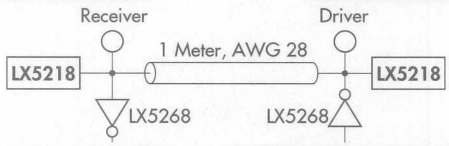
PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 20MHz



DRIVING WAVEFORM - 20MHz





NOTE:
For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

PACKAGE ORDER INFORMATION

T_J (°C)	DW Plastic SOWB 16-pin	PW Plastic TSSOP 20-pin
0 to 125	LX5218CDW	LX5218CPW
0 to 125	LX5219CDW	LX5219CPW

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5218CDWT)

ABSOLUTE MAXIMUM RATINGS (Note 1)

Continuous Termination Voltage	10V
Continuous Output Voltage Range	0 to 5.5V
Continuous Disable Voltage Range	0 to 5.5V
Operating Junction Temperature	0°C to 125°C
Storage Temperature Range	-65°C to +150°C
Solder Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device.

THERMAL DATA

DW PACKAGE:

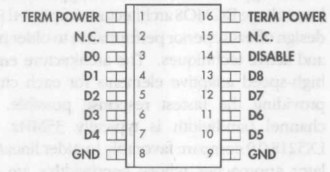
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

PW PACKAGE:

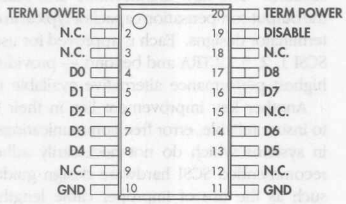
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	144°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



DW PACKAGE
(Top View)



PW PACKAGE
(Top View)

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RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Termination Voltage	V_{TERM}	3.5		5.5	V
High Level Disable Input Voltage	V_{IH}	2		V_{TERM}	V
Low Level Disable Input Voltage	V_{IL}	0		0.8	V
Operating Virtual Junction Temperature Range					
LX5218C		0		125	°C
LX5219C		0		125	°C

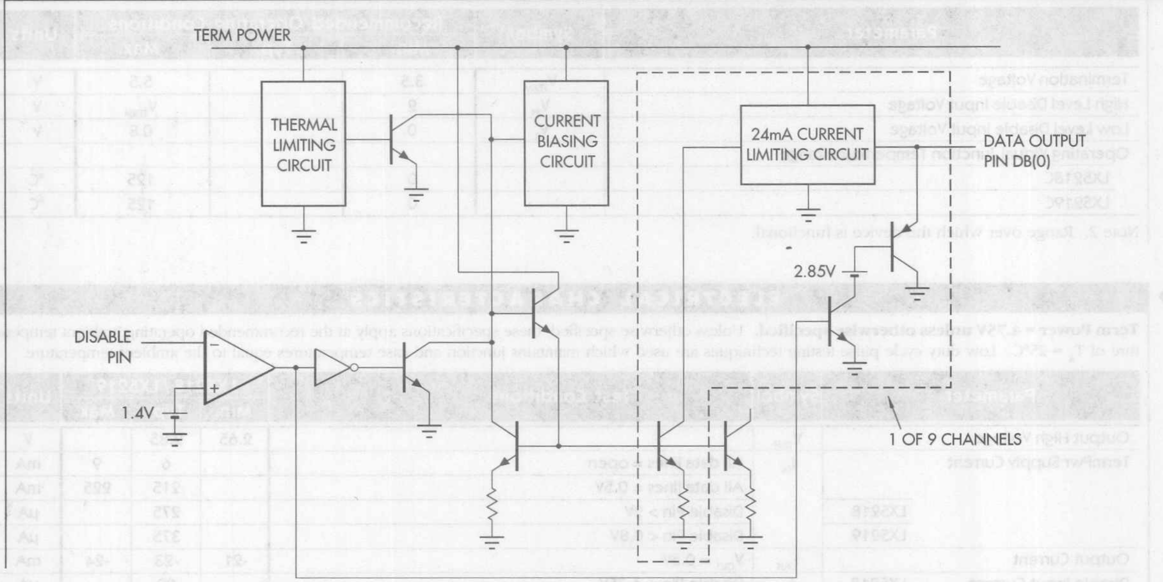
Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

Term Power = 4.75V unless otherwise specified. Unless otherwise specified, these specifications apply at the recommended operating ambient temperature of T_A = 25°C. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Parameter		Symbol	Test Conditions	LX5218 / LX5219 Min.	Typ.	Max.	Units
Output High Voltage		V_{OUT}		2.65	2.85		V
TermPwr Supply Current		I_{CC}	All data lines = open		6	9	mA
			All data lines = 0.5V		215	225	mA
	LX5218		Disable Pin > 2V		275		µA
	LX5219		Disable Pin < 0.8V		375		µA
Output Current		I_{OUT}	V_{OUT} = 0.5V	-21	-23	-24	mA
Disable Input Current	LX5218	I_{IN}	Disable Pin = 4.75V		90		µA
			Disable Pin = 0V		-10		nA
	LX5219		Disable Pin = 4.75V		10		nA
			Disable Pin = 0V		-90		µA
Output Leakage Current	LX5218	I_{OL}	Disable Pin = > 2.0V, V_O = 0.5V		10		nA
	LX5219		Disable Pin = < 0.8V, V_O = 0.5V		10		nA
Capacitance in Disabled Mode		C_{OUT}	V_{OUT} = 0V, frequency = 1MHz		4		pF
Channel Bandwidth		BW			35		MHz
Termination Sink Current, per Channel		I_{SINK}	V_{OUT} = 4V		60		mA

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Cable transmission theory suggests to optimize signal speed and quality, the termination should act both as an ideal voltage reference when the line is released (deasserted) and as an ideal current source when the line is active (asserted). Common active terminators, which consist of Linear Regulators in series with resistors (typically 110Ω), are a compromise. As the line voltage increases, the amount of current decreases linearly by the equation V = I * R. The LX5218/19, with its unique new architecture applies the maximum amount of current regardless of line voltage until the termination high threshold (2.85V) is reached.

Acting as a near ideal line terminator, the LX5218/19 closely reproduces the optimum case when the device is enabled. To enable the device the Disable Pin must be pulled logic **Low** or left **Open** (The LX5219 Disable Pin must be pulled Logic High or left open to enable the device). During this mode of operation, quiescent current is 6mA and the device will respond to line demands by delivering 24mA on assertion and by imposing 2.85V on deassertion. In order to disable the device, the Disable pin must be driven logic **High** (Logic Low for LX5219). This mode of operation places the device in a sleep state where a meager 275µA of quiescent current is consumed. Additionally, all outputs are in a Hi-Z (impedance) state. Sleep mode can be used for power conservation or to completely eliminate the terminator from the SCSI chain. In the second case, termination node capacitance is important to consider. The terminator will appear as a parasitic distributed capacitance on the line, which can detract from bus performance. For this reason, the LX5218/19 has been optimized to have only 4pF of capacitance per output in the sleep state.

POWER UP / POWER DOWN FUNCTION TABLE

Disable LX5218	Disable LX5219	Outputs	Quiescent Current
L	H	Enabled	6mA
H	L	HI Z	275µA
Open	Open	Enabled	6mA

An additional feature of the LX5218/19 is its compatibility with active negation drivers. The device handles up to 60mA of sink current for drivers which exceed the 2.85V output high.

GRAPH / CURVE INDEX

Waveforms

Characteristic Curves

FIGURE INDEX

Application Circuits

CHARACTERISTIC CURVES

FIGURE 1A. — RECEIVING WAVEFORM

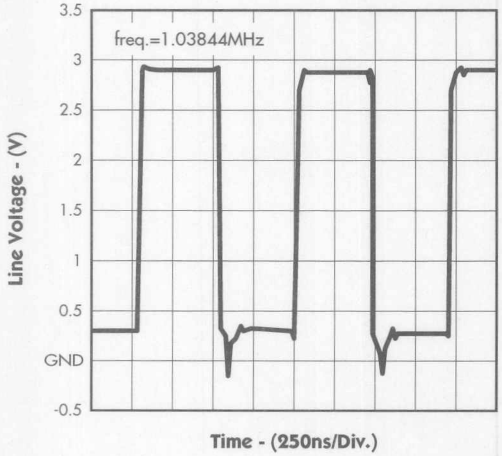
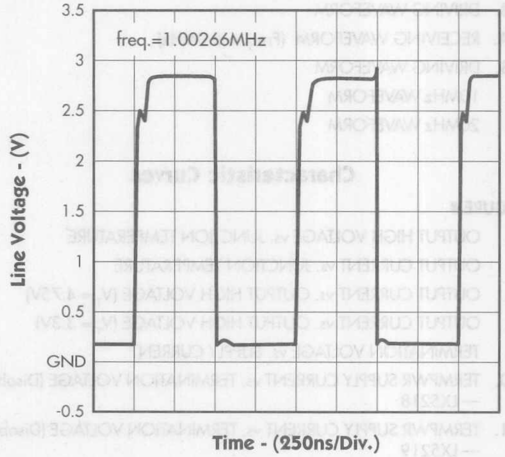
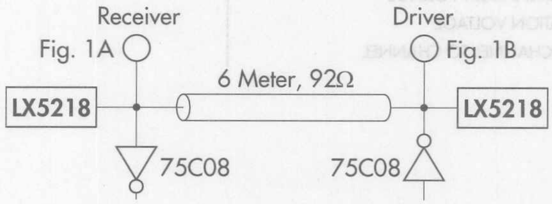


FIGURE 1B. — DRIVING WAVEFORM



END-DRIVEN CABLE



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CHARACTERISTIC CURVES

FIGURE 2A. — RECEIVING WAVEFORM

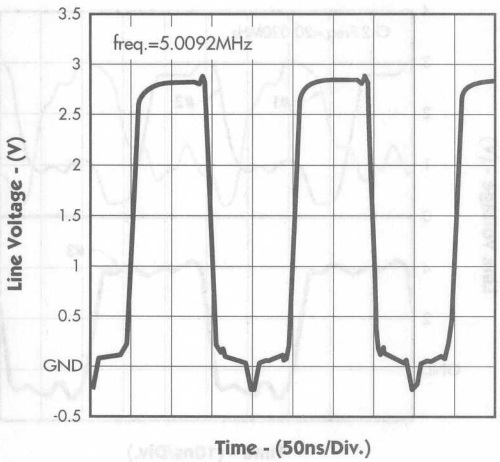
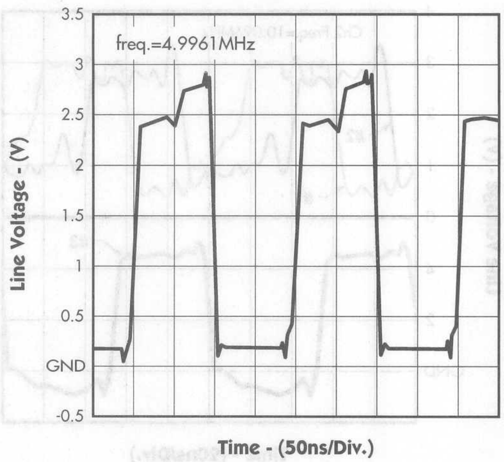
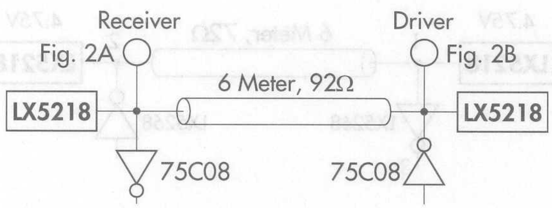


FIGURE 2B. — DRIVING WAVEFORM



END-DRIVEN CABLE



CHARACTERISTIC CURVES

FIGURE 3. — 10MHz WAVEFORM

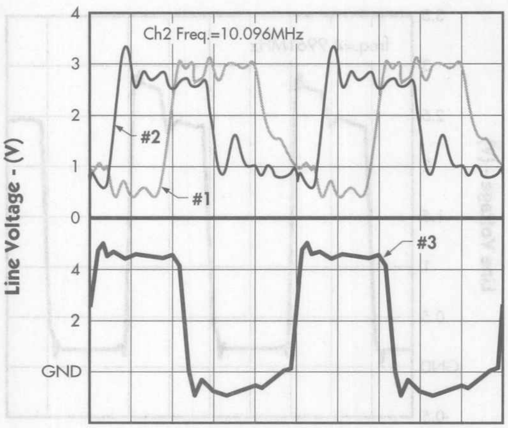
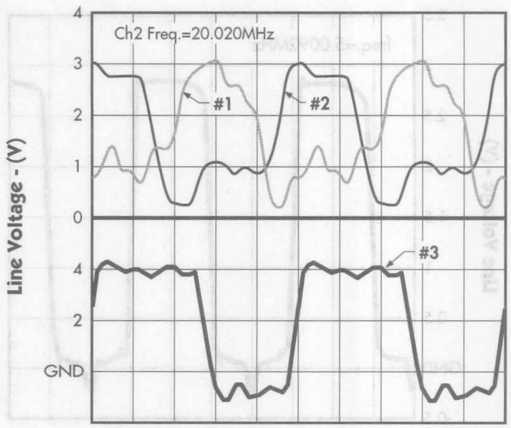
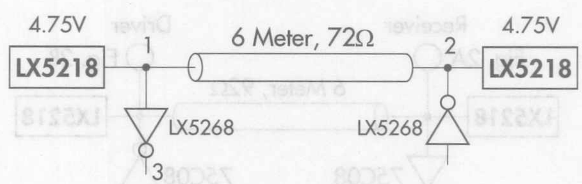


FIGURE 4. — 20MHz WAVEFORM





LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — OUTPUT HIGH VOLTAGE vs. JUNCTION TEMP.

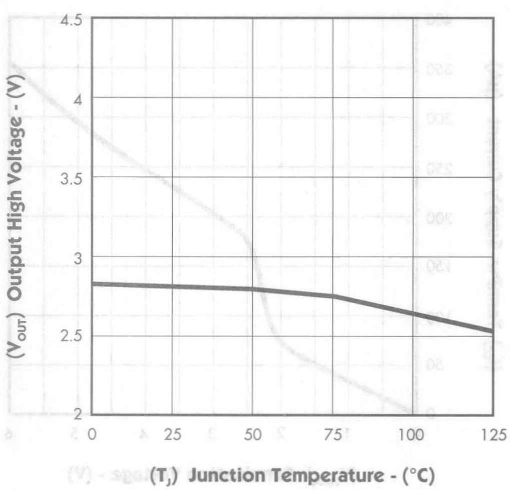


FIGURE 6. — OUTPUT CURRENT vs. JUNCTION TEMP.

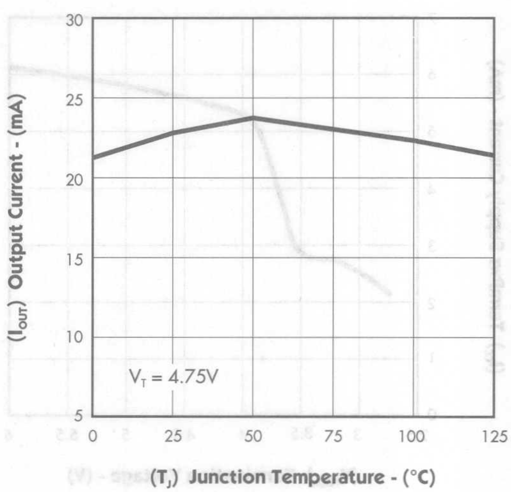


FIGURE 7. — OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE

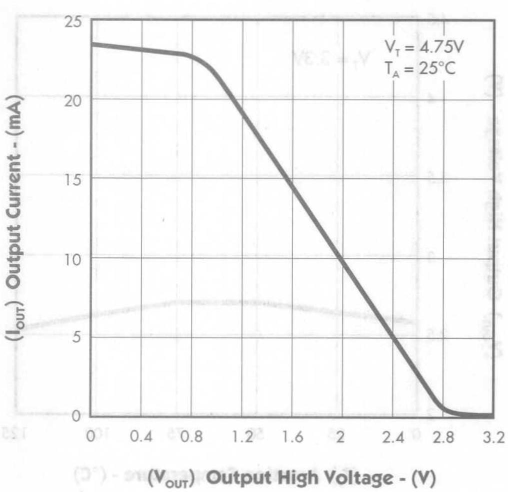
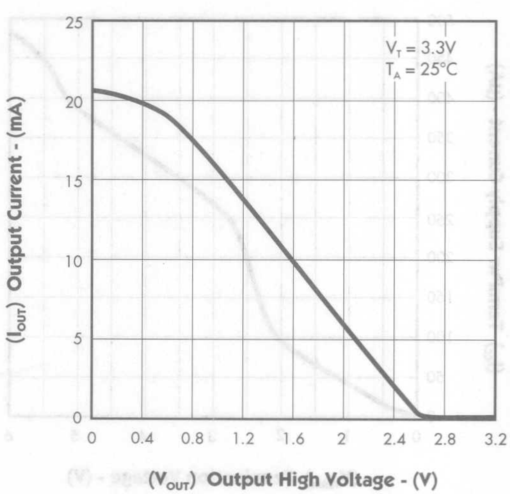


FIGURE 8. — OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE



CHARACTERISTIC CURVES

FIGURE 9. — TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE

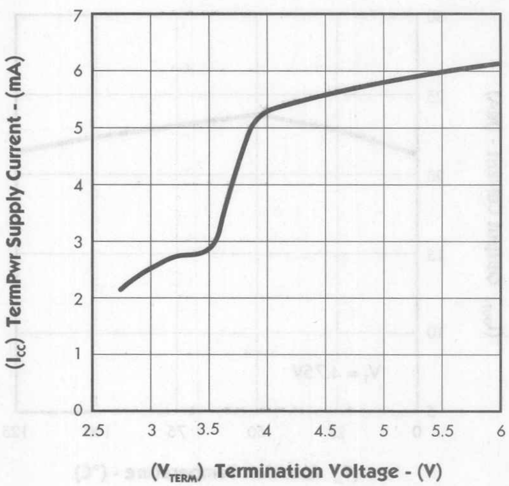


FIGURE 10. — LX5218 TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled)

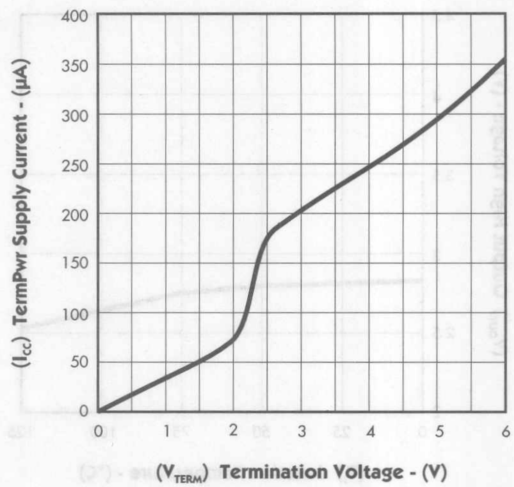


FIGURE 11. — LX5219 TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled)

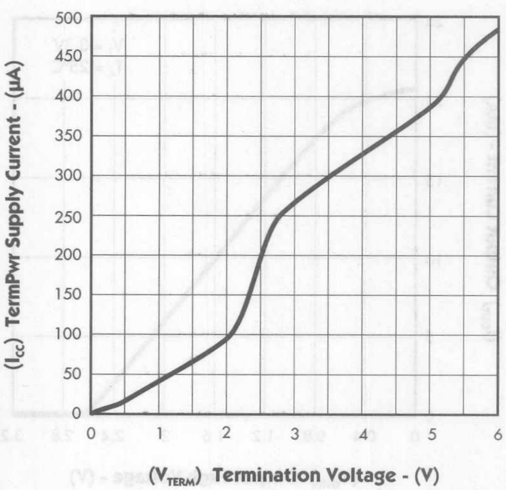
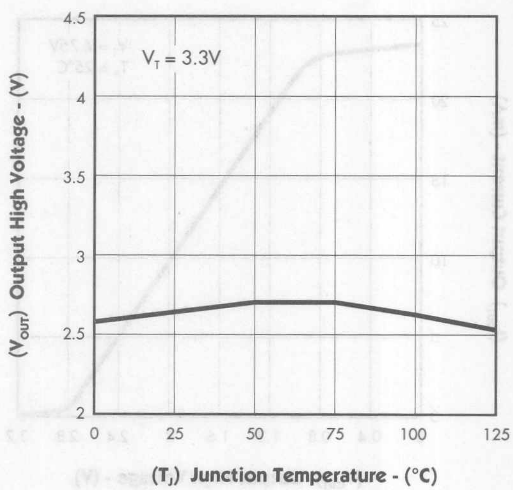


FIGURE 12. — OUTPUT HIGH VOLTAGE vs. JUNCTION TEMP.



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 13. — OUTPUT CURRENT vs. JUNCTION TEMP.

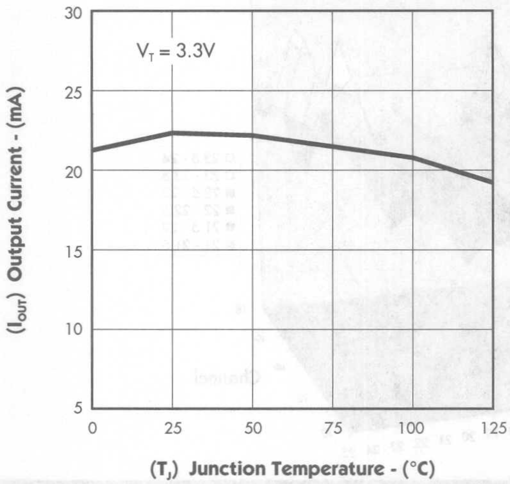


FIGURE 14. — OUTPUT HIGH VOLTAGE vs. TERMINATION VOLTAGE

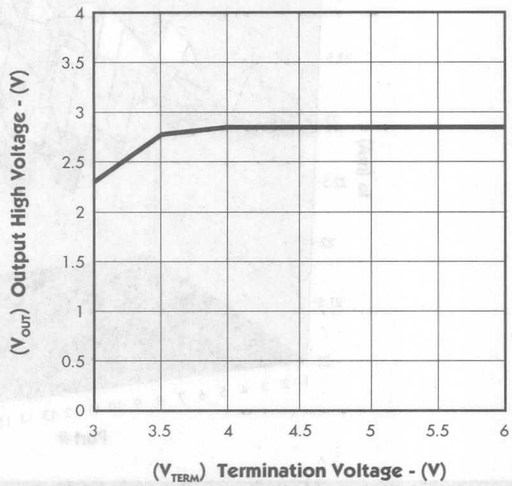
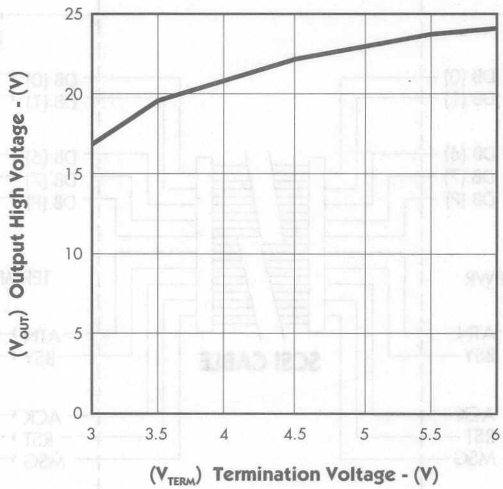
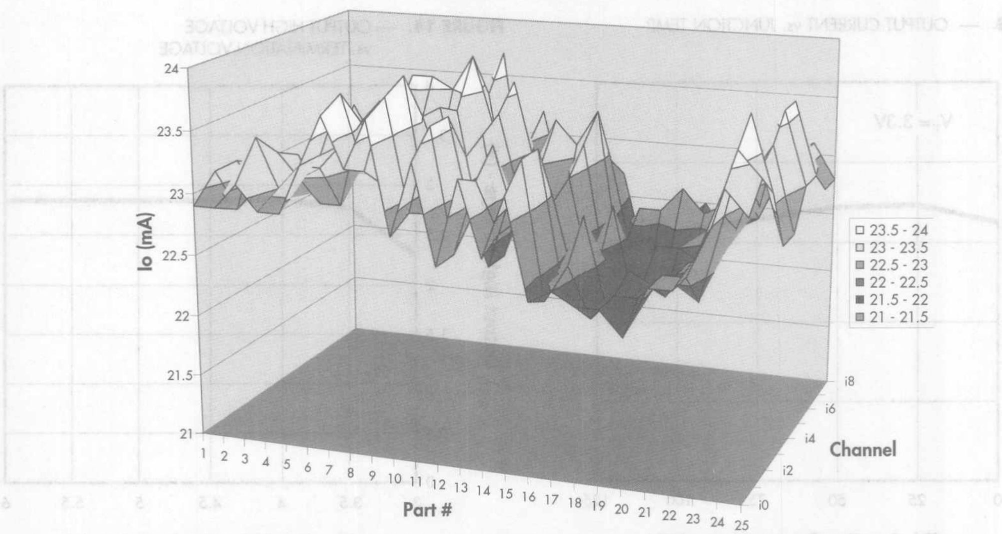


FIGURE 15. — OUTPUT CURRENT vs. TERMINATION VOLTAGE



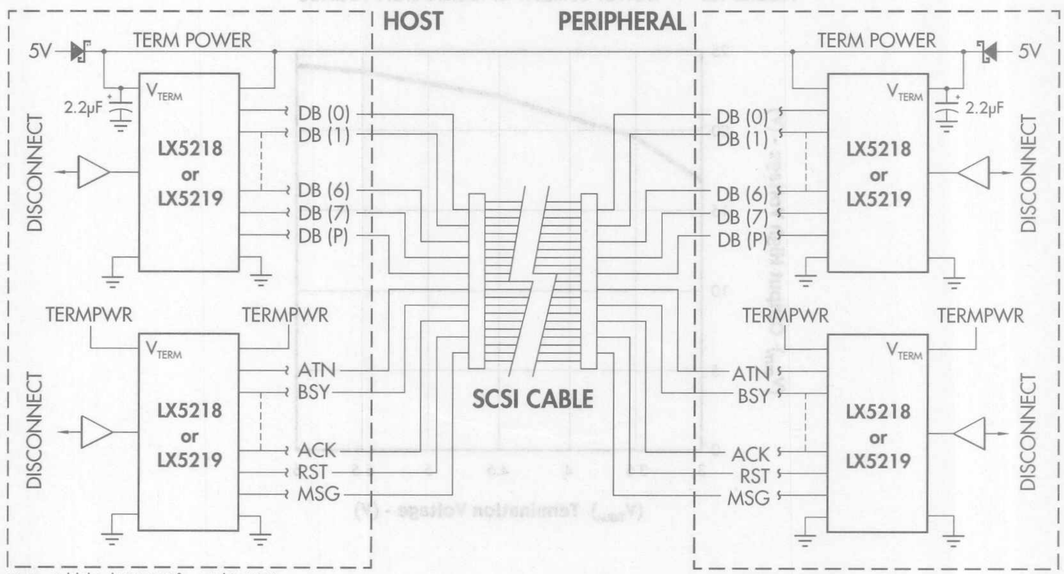
CHARACTERISTIC CURVES

FIGURE 16. — OUTPUT CURRENT CHANNEL TO CHANNEL MATCHING



APPLICATION SCHEMATIC

FIGURE 17 — 8-BIT SCSI SYSTEM APPLICATION



Note: Add third LX5218 for 16-bit SCSI

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX5268

40MHz Single-Ended Inverting 6-Channel Bus Transceiver

PRELIMINARY DATA SHEET

DESCRIPTION

The LX5268 is a six-channel inverting transceiver that is used to drive and receive the signals from the single-ended Small Computer Systems Interface (SCSI) bus. The inverting drivers are programmable to function either as totem-pole or as open-drain outputs. The open-drain mode is used to drive the wired-OR lines of SCSI (BSY, SEL, RST). The totem-pole outputs provide active signal negation for higher signal-to-noise ratios on the bus. All the drivers and receivers may be disabled with the CE control pin. The A inputs of the drivers are taken high to ensure a low on the output when the input is open or to eliminate external pullup resistors. The drivers also feature controlled turn-on and turn-off times to reduce crosstalk in and RF emissions from the SCSI cable.

The LX5268 inverting receivers exhibit 600mV of hystersis and incorporate a 5ns pulse filter to reject high-frequency noise coupling from adjacent signal lines. These improvements to typically single-ended SCSI I/O's provide less data errors and higher data throughput with less noise emissions. The DE/RE enable has a pulldown resistor on the input to ensure that the receiver is enabled when the DE/RE input is open.

The switching speeds of the LX5268 are sufficent to transfer data over the data bus at 80-million transfers per second. Proper bus termination is required to meet these data rates. Linfinity offers a broad range of terminator solutions such as the LX5218, 9-Channel Current Mode Terminator and the LX5208, 18-Channel Boulay Terminator. The pin assignment of the LX5268 and its enabling logic make this device applicable for the data path (8 data bits plus parity) for the SCSI bus.

This device is available in the space-efficient shrink-small-outline package (SSOP) with 25-mil pin pitch. Each of the 6 identical channels conform to the requirements of ANSI X3.131 - 1986 (SCSI-1) and the proposed SCSI-2 and -3 standards.

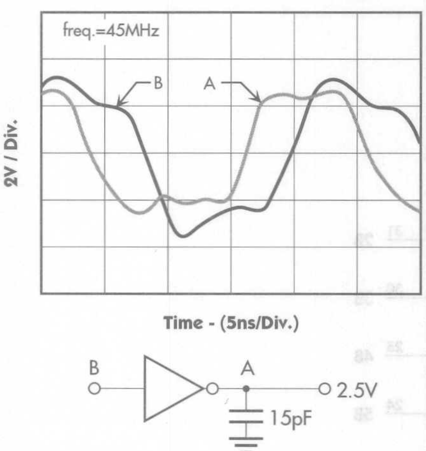
The LX5268 is characterized for operation from 0°C to 70°C.

KEY FEATURES

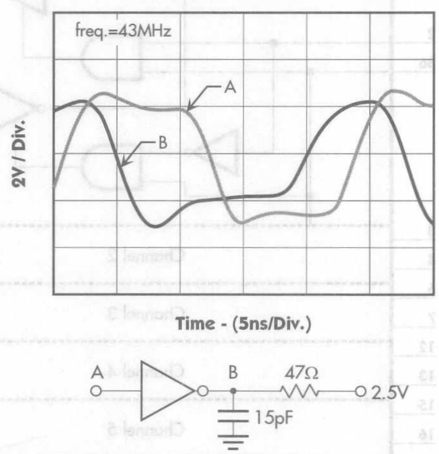
- ■ **OUTPUT CAPACITANCE: 15pF Typ.**
- ■ **ACTIVE NEGATION (TOTEM-POLE) OR OPEN-DRAIN; SELECTABLE DRIVER OUTPUTS**
- □ TOTEM-POLE; 40mA SOURCE / 48mA SINK CURRENT
- □ OPEN-DRAIN; 48mA SINK CURRENT
- □ CONTROLLED DRIVER RISE AND FALL TIMES 6ns TYPICAL
- □ LOW SKEW, $t_{sk(lim)}$ ... 4ns TYPICAL
- □ HIGH RECEIVER INPUT VOLTAGE HYSTERESIS - 600mV typ.
- □ RECEIVER INPUT NOISE PULSE FILTER - 5ns MAXIMUM
- □ EACH DRIVER AND RECEIVER MEETS ANSI X3.131-1986 (SCSI-1) AND SCSI-2 & 3 STANDARDS
- □ POWER UP/DOWN GLITCH PROTECTION
- □ HIGH IMPEDANCE WITH V_{CC} AT 0V
- □ COMPATIBLE WITH ACTIVE TERMINATORS FROM LINFINITY:
  - LX5218, 9-Channel ULTRA
  - LX5212, 9-Channel Low Capacitance
  - LX5207, 18-Channel Low Capacitance

PRODUCT HIGHLIGHT

RECEIVING WAVEFORM



DRIVING WAVEFORM



PACKAGE ORDER INFO

T_A (°C)	DB Plastic SSOP 36-pin
0 to 70	LX5268CDB

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5268CDBT)

NOTE: For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 Western Avenue, Garden Grove, CA. 92841

LX5268

40MHz Single-Ended Inverting 6-Channel Bus Transceiver

Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage Range (V_{CC})	-0.5V to 7V
Bus Voltage Range	-0.5V to V_{DD} + 0.5V
Data I/O and Control (A-side) Voltage Range	-0.5V to V_{DD} + 0.5V
Continuous Power Dissipation	Internally Limited
Operating Junction Temperature	
Plastic (DB Package)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS

DB PACKAGE
(Top View)

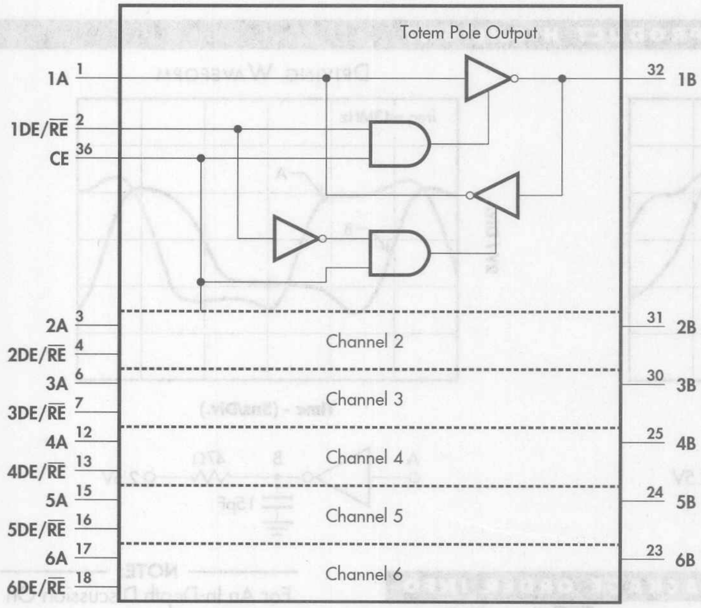
THERMAL DATA

DB PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

FUNCTIONAL BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter		Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage		V_{CC}	4.75	5	5.25	V
High-Level Input Voltage		V_{IH}	2.0			V
Low-Level Input Voltage		V_{IL}			0.8	V
High-Level Output Current	Driver	I_{OH}			-40	mA
	Receiver				-8	mA
Low-Level Output Current	Driver	I_{OL}			48	mA
	Receiver				8	mA
Operating Virtual Junction Temperature Range:						
LX5268		T_A	0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5268 Min.	Typ.	Max.	Units
Driver Section (Totem-Pole)							
High-Level Output Voltage	V_{OH}	I_{OH} = -20mA	See Figure 1	2.0			V
Low-Level Output Voltage	V_{OL}	I_{OL} = 48mA	See Figure 1			0.5	V
High-Impedance State Output Current	I_{OZ}	V_O = GND				-1	µA
		$V_O = V_{CC}$				1	µA
Output Capacitance	C_{OUT}				15		pF
Receiver Section							
High-Level Output Voltage	V_{OH}	I_{OH} = -8mA	See Figure 2	2	3.5		V
Low-Level Output Voltage	V_{OL}	I_{OL} = 8mA	See Figure 2		0.2	0.8	V
Positive Going Input Threshold Voltage	V_{T+}				1.7	2	V
Negative Going Input Threshold Voltage	V_{T-}			0.8	1.1		V
Input Hysteresis	V_{HYS}				0.6		V
High-Level Input Current	I_{IH}	V_{IH} = 2V	See Figure 2		500		µA
Low-Level Input Current	I_{IL}	V_{IL} = 0.5V	See Figure 2		-500		µA
High-Impedance State Output Current	I_{OZ}	V_O = GND	See Figure 2			-1	mA
		$V_O = V_{CC}$				10	µA
Driver Switching Section (Open-Drain) See Figure 4							
Propagation Delay Time, High to Low	t_{PZL}				25	40	ns
Propagation Delay Time, Low to High	t_{PLZ}				25	40	ns
Pulse Skew (t_{PLZ} - t_{PZL})	t_{SK}	See Note 3			4		ns
Rise Time	t_R	C_L = 15pF		4	8		ns
Fall Time	t_F	C_L = 15pF		4	8		ns
Driver Switching Section (Totem-Pole) See Figure 3							
Propagation Delay Time, High to Low	t_{PHL}				10	20	ns
Propagation Delay Time, Low to High	t_{PLH}				10	20	ns
Pulse Skew (t_{PHL} - t_{PLH})	t_{SK}	See Note 3				9	ns
Rise Time	t_R	C_L = 15pF		4	6		ns
Fall Time	t_F	C_L = 15pF		4	6		ns

Note 3. This specification applies to any 5°C band within the operating temperature range.

ELECTRICAL CHARACTERISTICS (Continued)

Parameter		Symbol	Test Conditions	LX5268 Min.	Typ.	Max.	Units
Receiver Switching Section (See Figure 5)							
Propagation Delay Time, High to Low Level Output		t_{PHL}	See Figure 5		10	16	ns
Propagation Delay Time, Low to High Level Output		t_{PLH}	See Figure 5		10	16	ns
Enable Time (3-state output) to High Level		t_{PZH}			20	30	ns
Enable Time (3-state output) to Low Level		t_{PZL}			20	30	ns
Disable Time (3-state output) from High Level		t_{PHZ}			20	30	ns
Disable Time (3-state output) from Low Level		t_{PLZ}			20	30	ns
Pulse Skew (t_{PHL} - t_{PLH})		$t_{SK(LIM)}$	V_{CC} = 5V, See Note 3		9		ns
Rise Time		t_R			5		ns
Fall Time		t_F			5		ns
Rejected Noise Pulse Duration		t_W			5		ns
Supply Section							
Operating Mode	Driver Enabled	I_{DD}	No Load, All Inputs Open, CE = V_{CC}		2		mA
	Driver Disabled		No Load, All Inputs Open, CE = V_{CC}		1		mA
Standby Mode			No Load, All Inputs Open, CE = 0V		100		µA

PARAMETER MEASUREMENT INFORMATION

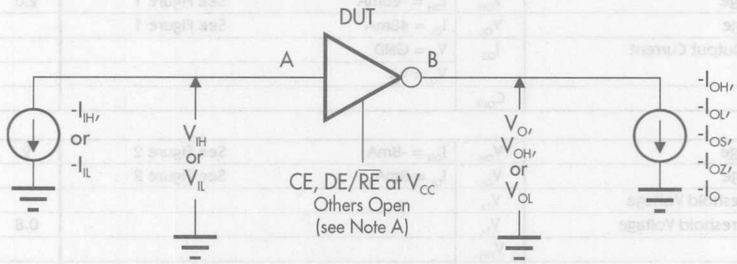


FIGURE 1. — DRIVER TEST CIRCUIT and INPUT CONDITIONS

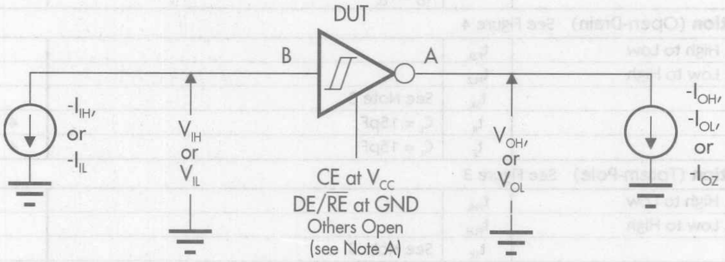
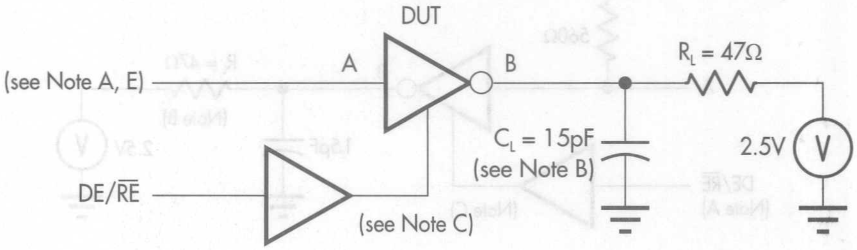


FIGURE 2. — RECEIVER TEST CIRCUIT and INPUT CONDITIONS

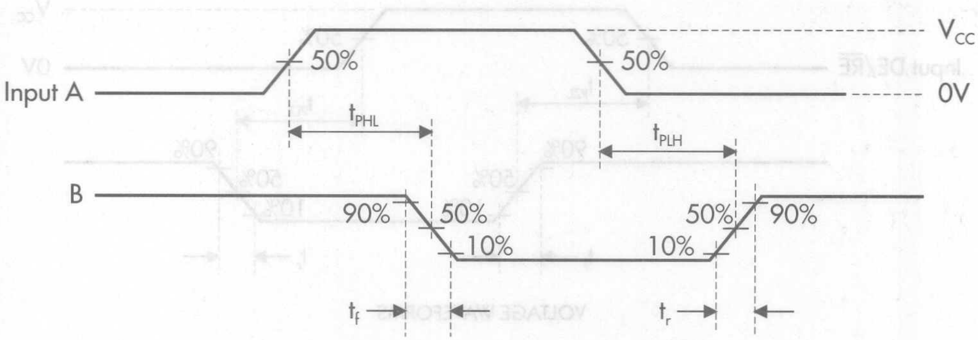
Note A. For the I_{OZ} test, the CE input is at GND and all other inputs are grounded.

LINFINITY MICROELECTRONICS

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT (Totem Pole)

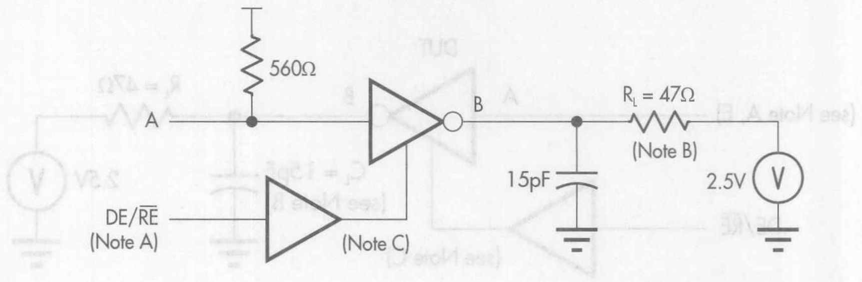


VOLTAGE WAVEFORMS

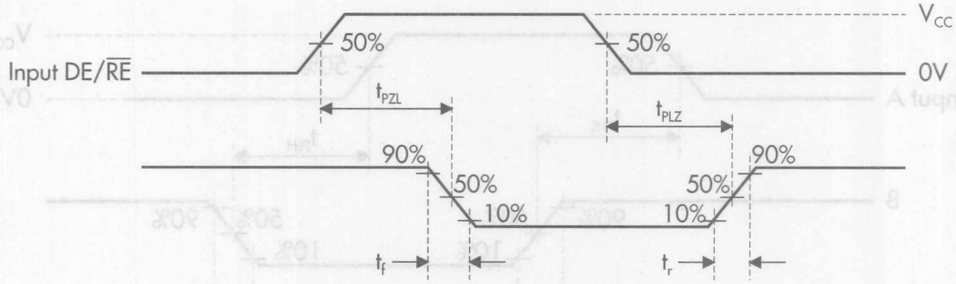
FIGURE 3. — DRIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, 50% duty cycle, t_r & $t_f \leq 6$ ns, and $Z_O = 50\Omega$.
B. C_L includes probe and jig capacitance.
C. CE is at V_{CC} and DE is at V_{CC}.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

FIGURE 4. — DRIVER TEST CIRCUIT, OPEN DRAIN and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, 50% duty cycle, t_r & t_f ≤ 6 ns, and Z_O = 50Ω.
B. C_L includes probe and jig capacitance.
C. CE is at V_{CC}.

PARAMETER MEASUREMENT INFORMATION

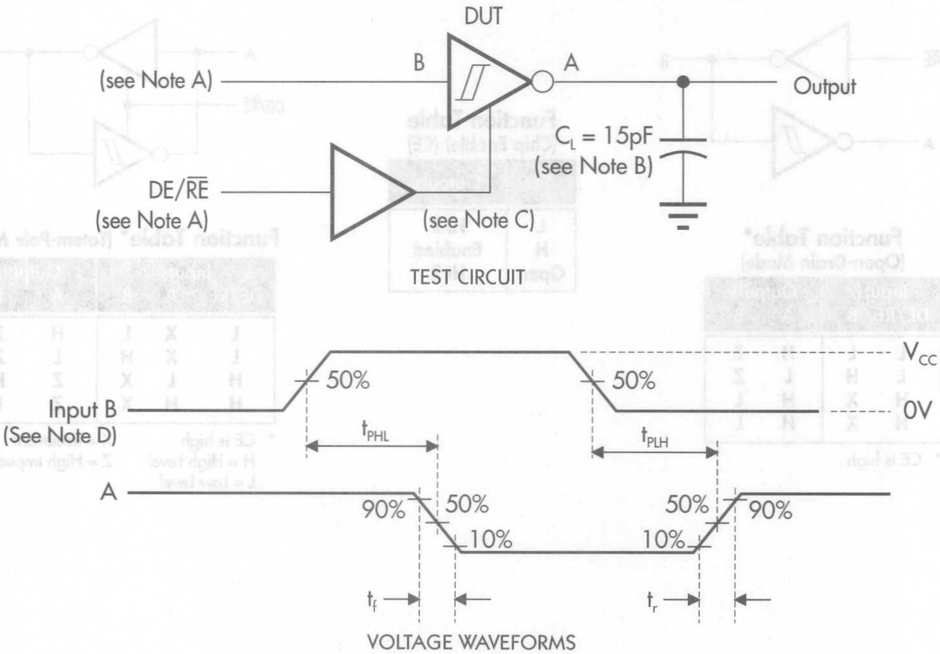


FIGURE 5. — RECEIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, 50% duty cycle, t_r & t_f ≤ 6 ns, and Z_O = 50Ω.
B. C_L includes probe and jig capacitance.
C. CE is at V_{CC}.
D. DE/$\overline{RE}$ is at ground.

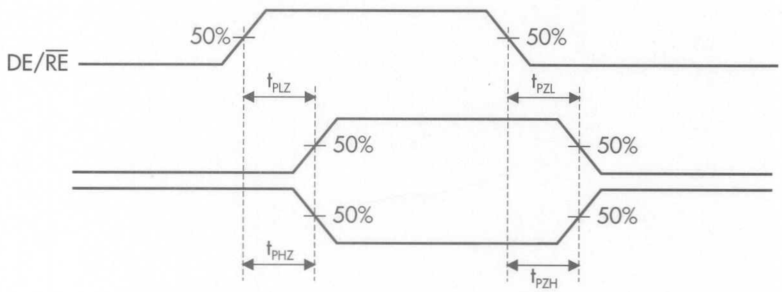
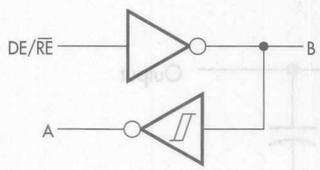


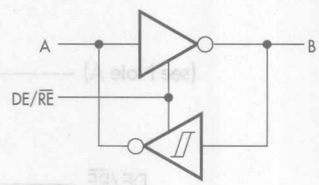
FIGURE 6. — RECEIVER ENABLE DELAY WAVEFORMS

FUNCTIONAL DESCRIPTION

Open Drain Output



Totem Pole Output



Function Table
(Chip Enable) (CE)

CE	Outputs
L	Hi Z
H	Enabled
Open	Hi Z

Function Table*
(Open-Drain Mode)

Inputs DE/$\overline{RE}$	Inputs B	Outputs A	Outputs B
L	L	H	Z
L	H	L	Z
H	X	H	L
H	X	H	L

* CE is high

Function Table* (Totem-Pole Mode)

Inputs DE/$\overline{RE}$	Inputs A	Inputs B	Outputs A	Outputs B
L	X	L	H	Z
L	X	H	L	Z
H	L	X	Z	H
H	H	X	Z	L

* CE is high
H = High Level
L = Low Level
X = Irrelevant
Z = High Impedance

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THE INFINITE POWER OF INNOVATION

LX5269

40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

PRELIMINARY DATA SHEET

DESCRIPTION

The LX5269 is a six-channel, non-inverting transceiver that is used to drive and receive the signals from the single-ended Small Computer Systems Interface (SCSI) bus. The totem-pole outputs provide active signal negation for higher signal-to-noise ratios on the bus. All the drivers and receivers may be disabled with the CE control pin. The A inputs of the drivers are taken low to ensure a low on the output when the input is open or to eliminate external pullup resistors. The drivers also feature controlled turn-on and turn-off times to reduce crosstalk in and RF emissions from the SCSI cable.

The LX5269 non-inverting receivers exhibit 600mV of hysteresis and incorporates a 5ns pulse filter to reject high-frequency noise coupling from adjacent signal lines. These improvements to typically single-ended SCSI I/O's provide less data errors and higher data throughput with less noise emissions. The DE/RE enable has a pulldown resistor on the input to ensure that the receiver is enabled when the DE/RE input is open.

The switching speeds of the LX5269 are sufficent to transfer data over the data bus at 80-million transfers per second. Proper bus termination is required to meet these data rates. Linfinity offers a broad range of terminator solutions such as the LX5218, 9-Channel Current Mode Terminator and the LX5208, 18-Channel Boulay Terminator. The pin assignment of the LX5269 and its enabling logic make this device applicable for the data path (8 data bits plus parity) for the SCSI bus.

This device is available in the space-efficient shrink-small-outline package (SSOP) with 25-mil pin pitch. Each of the 6 identical channels conform to the requirements of ANSI X3.131 - 1986 (SCSI-1) and the proposed SCSI-2 and -3 standards.

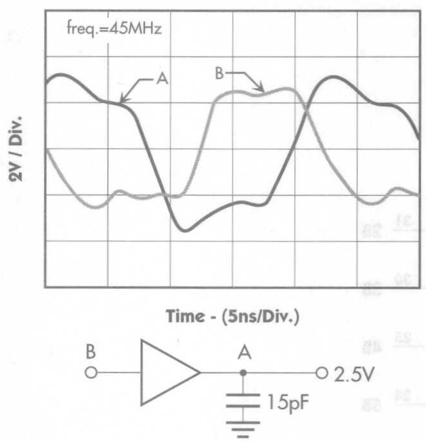
The LX5269 is characterized for operation from 0°C to 70°C.

KEY FEATURES

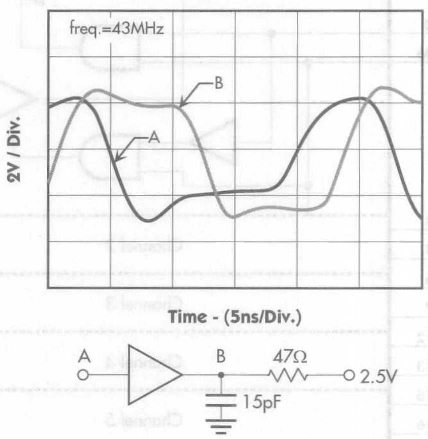
- **OUTPUT CAPACITANCE: 15pF Typ.**
- **ACTIVE NEGATION (TOTEM-POLE) OR OPEN-DRAIN; SELECTABLE DRIVER OUTPUTS**
- TOTEM-POLE; 40mA SOURCE / 48mA SINK CURRENT
- OPEN-DRAIN; 48mA SINK CURRENT
- CONTROLLED DRIVER RISE AND FALL TIMES 6ns TYPICAL
- LOW SKEW, $t_{sk(lim)}$ ... 4ns TYPICAL
- HIGH RECEIVER INPUT VOLTAGE HYSTERESIS - 600mV typ.
- RECEIVER INPUT NOISE PULSE FILTER - 5ns MAXIMUM
- EACH DRIVER AND RECEIVER MEETS ANSI X3.131-1986 (SCSI-1) AND SCSI-2 & 3 STANDARDS
- POWER UP/DOWN GLITCH PROTECTION
- HIGH IMPEDANCE WITH V_{CC} AT 0V
- COMPATIBLE WITH ACTIVE TERMINATORS FROM LINFINITY:
  - LX5218, 9-Channel ULTRA
  - LX5212, 9-Channel Low Capacitance
  - LX5207, 18-Channel Low Capacitance

PRODUCT HIGHLIGHT

RECEIVING WAVEFORM



DRIVING WAVEFORM



PACKAGE ORDER INFO

T_A (°C)	DB Plastic SSOP 36-pin
0 to 70	LX5269CDB

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5269CDBT)

NOTE: For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

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LX5269

40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

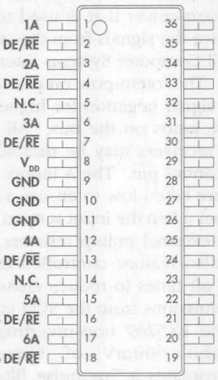
Preliminary Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage Range (V_{CC})	-0.5V to 7V
Bus Voltage Range	-0.5V to V_{DD} + 0.5V
Data I/O and Control (A-side) Voltage Range	-0.5V to V_{DD} + 0.5V
Continuous Power Dissipation	Internally Limited
Operating Junction Temperature	
Plastic (DB Package)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



DB PACKAGE
(Top View)

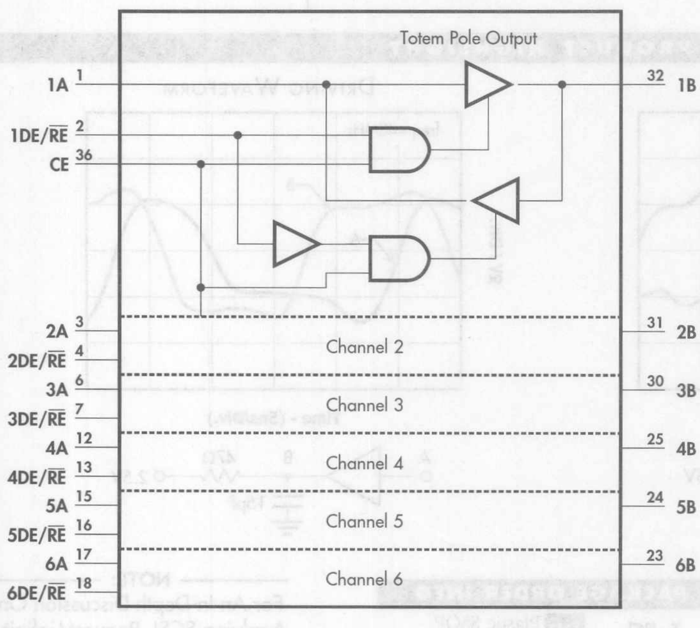
THERMAL DATA

DB PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

FUNCTIONAL BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter		Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Supply Voltage		V_{CC}	4.75	5	5.25	V
High-Level Input Voltage		V_{IH}	2.0			V
Low-Level Input Voltage		V_{IL}			0.8	V
High-Level Output Current	Driver	I_{OH}			-40	mA
	Receiver				-8	mA
Low-Level Output Current	Driver	I_{OL}			48	mA
	Receiver				8	mA
Operating Virtual Junction Temperature Range:						
LX5269		T_A	0		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of 0°C ≤ T_A ≤ 70°C. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5269 Min.	Typ.	Max.	Units
Driver Section (Totem-Pole)							
High-Level Output Voltage	V_{OH}	I_{OH} = -20mA	See Figure 1	2.0			V
Low-Level Output Voltage	V_{OL}	I_{OL} = 48mA	See Figure 1			0.5	V
High-Impedance State Output Current	I_{OZ}	V_O = GND				-1	µA
		$V_O = V_{CC}$				1	µA
Output Capacitance	C_{OUT}				15		pF
Receiver Section							
High-Level Output Voltage	V_{OH}	I_{OH} = -8mA	See Figure 2	2	3.5		V
Low-Level Output Voltage	V_{OL}	I_{OL} = 8mA	See Figure 2		0.2	0.8	V
Positive Going Input Threshold Voltage	V_{T+}				1.7	2	V
Negative Going Input Threshold Voltage	V_{T-}			0.8	1.1		V
Input Hysteresis	V_{HYS}				0.6		V
High-Level Input Current	I_{IH}	V_{IH} = 2V	See Figure 2		500		µA
Low-Level Input Current	I_{IL}	V_{IL} = 0.5V	See Figure 2		-500		µA
High-Impedance State Output Current	I_{OZ}	V_O = GND	See Figure 2			-1	mA
		$V_O = V_{CC}$				10	µA
Driver Switching Section (Totem-Pole) See Figure 3							
Propagation Delay Time, High to Low	t_{PHL}				10	20	ns
Propagation Delay Time, Low to High	t_{PLH}				10	20	ns
Pulse Skew (t_{PHL} - t_{PLH})	t_{SK}	See Note 3				9	ns
Rise Time	t_R	C_L = 15pF		4	6		ns
Fall Time	t_F	C_L = 15pF		4	6		ns

Note 3. This specification applies to any 5°C band within the operating temperature range.

ELECTRICAL CHARACTERISTICS (Continued)

Parameter		Symbol	Test Conditions	LX5269 Min.	LX5269 Typ.	LX5269 Max.	Units
Receiver Switching Section (See Figure 4)							
Propagation Delay Time, High to Low Level Output		t_{PHL}	See Figure 4		10	16	ns
Propagation Delay Time, Low to High Level Output		t_{PLH}	See Figure 4		10	16	ns
Enable Time (3-state output) to High Level		t_{PZH}			20	30	ns
Enable Time (3-state output) to Low Level		t_{PZL}			20	30	ns
Disable Time (3-state output) from High Level		t_{PHZ}			20	30	ns
Disable Time (3-state output) from Low Level		t_{PLZ}			20	30	ns
Pulse Skew (t_{PHL} - t_{PLH})		$t_{SK\,(LIM)}$	V_{CC} = 5V, See Note 3			9	ns
Rise Time		t_R			5		ns
Fall Time		t_F			5		ns
Rejected Noise Pulse Duration		t_W			5		ns
Supply Section							
Operating Mode	Driver Enabled	I_{DD}	No Load, All Inputs Open, CE = V_{CC}		2		mA
	Driver Disabled		No Load, All Inputs Open, CE = V_{CC}		1		mA
Standby Mode			No Load, All Inputs Open, CE = 0V		100		µA

PARAMETER MEASUREMENT INFORMATION

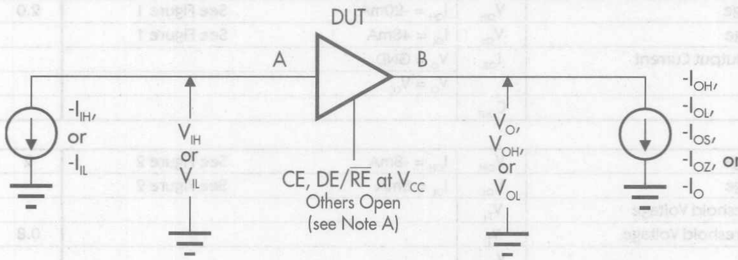


FIGURE 1. — DRIVER TEST CIRCUIT and INPUT CONDITIONS

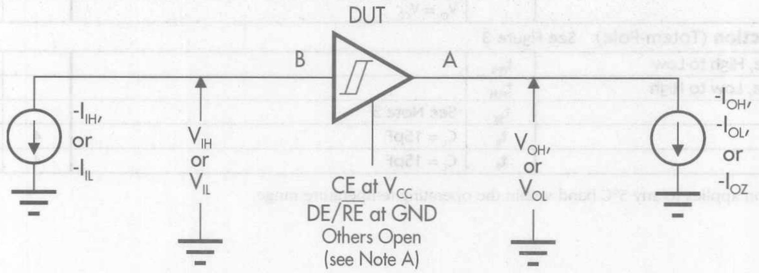
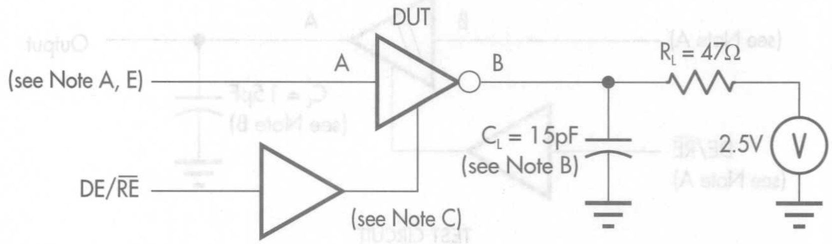


FIGURE 2. — RECEIVER TEST CIRCUIT and INPUT CONDITIONS

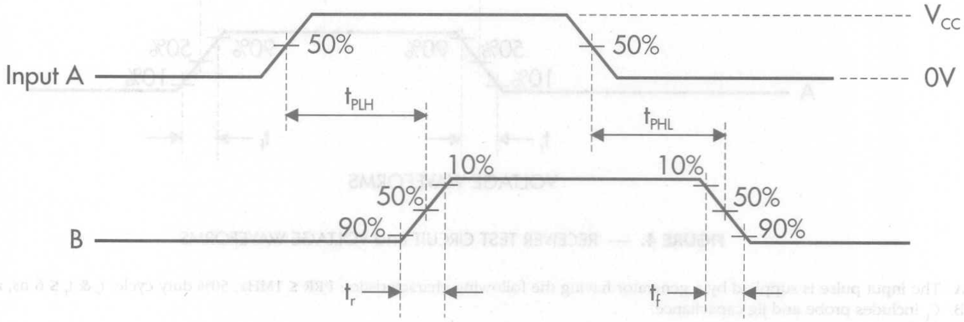
Note A. For the I_{OZ} test, the CE input is at GND and all other inputs are grounded.

LINFINITY MICROELECTRONICS

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT (Totem Pole)



VOLTAGE WAVEFORMS

FIGURE 3. — DRIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, 50% duty cycle, t_r & t_f ≤ 6 ns, and $Z_O = 50\Omega$.
B. C_L includes probe and jig capacitance.
C. CE is at V_{CC} and DE is at V_{CC}.

PARAMETER MEASUREMENT INFORMATION

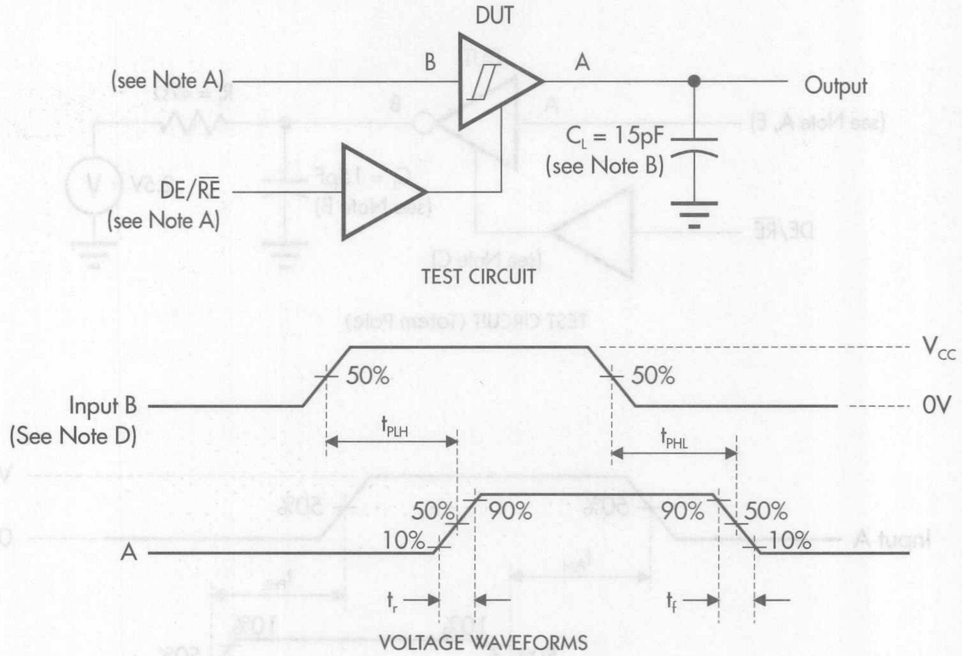


FIGURE 4. — RECEIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1MHz, 50% duty cycle, t_r & t_f ≤ 6 ns, and Z_O = 50Ω.
B. C_L includes probe and jig capacitance.
C. CE is at V_{CC}.
D. DE/$\overline{RE}$ is at ground.

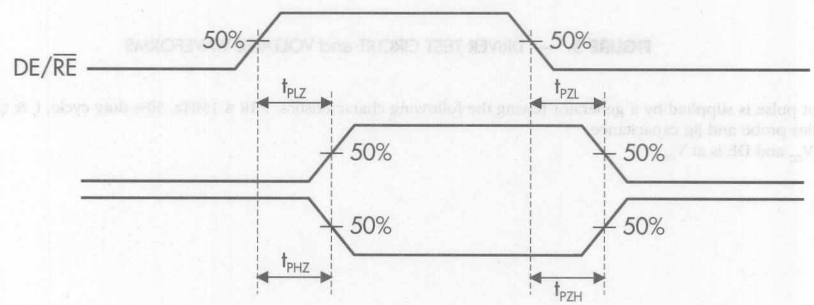


FIGURE 5. — RECEIVER ENABLE DELAY WAVEFORMS

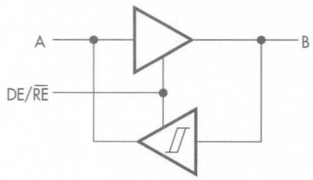
LINFINITY MICROELECTRONICS

FUNCTIONAL DESCRIPTION

Function Table
(Chip Enable) (CE)

CE	Outputs
L	Hi Z
H	Enabled
Open	Hi Z

Totem Pole Output



Function Table* (Totem-Pole Mode)

Inputs			Outputs	
DE/$\overline{RE}$	A	B	A	B
L	X	L	L	Z
L	X	H	H	Z
H	L	X	Z	L
H	H	X	Z	H

* CE is high
H = High Level
L = Low Level
X = Irrelevant
Z = High Impedance

Notes

Thumb Index

8

LINFINITY
MICROELECTRONICS

LINFINITY
MICROELECTRONICS

Section Index

SIGNAL CONDITIONING PRODUCTS

Operational Amplifiers

Voltage Reference

Bold = New Product, ****Bold Italic**** = Preliminary

LINFINITY MICROELECTRONICS

Selection Guide

SIGNAL CONDITIONING PRODUCTS

Operational Amplifiers

DEVICE TYPE	DESCRIPTION	KEY FEATURES	CHARACTERISTICS	PACKAGES
SG143/343	GENERAL PURPOSE HIGH-VOLTAGE OP-AMP. PAGE # 8-45	1. ±40V supply voltage range. 2. ±37V output voltage swing. 3. ±24V common mode voltages. 4. Over-voltage protection. 5. Output short circuit protection. 6. Internally compensated.	$V_{O(PK)}$ ±22V; SlewRate 2.5V/µs; $V_{CC(MAX)}$ ±40V; $I_{CC(MAX)}$ 4mA	Y, T
SG1536/1436	GENERAL PURPOSE HIGH-VOLTAGE OP-AMP. PAGE # 8-49	1. ±40V supply voltage range. 2. ±37V output voltage swing. 3. ±24V common mode voltages. 4. Over-voltage protection. 5. Output short circuit protection. 6. Internally compensated.	$V_{O(PK)}$ ±22V; SlewRate 2V/µs; $V_{CC(MAX)}$ ±40V; $I_{CC(MAX)}$ 4mA	Y, T, M

Voltage Reference Circuits

DEVICE TYPE	DESCRIPTION	KEY FEATURES	PACKAGES
LM385/385B	1.2 & 2.5V MICROPOWER VOLTAGE REFERENCE. PAGE # 8-7	1. Guaranteed 1% initial accuracy (LM385B-1.2). 2. Guaranteed 2.5% initial accuracy (LM385-1.2). 3. Guaranteed 1.5% initial accuracy (LM385B-2.5). 4. Guaranteed 3% initial accuracy (LM385-2.5). 5. Guaranteed 20µA operating current. 6. Low temperature coefficient. 7. Operating current of 20µA to 20mA. 8. Very low dynamic impedance .... 1Ω.	DM
LX1004	1.2 & 2.5V MICROPOWER VOLTAGE REFERENCE. PAGE # 8-15	1. Guaranteed ±4mV accuracy (LX1004-1.2). 2. Guaranteed ±20mV accuracy (LX1004-2.5). 3. Guaranteed 10µA operating current. 4. Guaranteed temperature performance. 5. Operates up to 20mA. 6. Very low dynamic impedance.	DM, LP
LX1431	PROGRAMMABLE REFERENCES. PAGE # 8-23	1. Guaranteed 0.4% initial voltage tolerance. 2. 0.1Ω typical dynamic output impedance. 3. Fast turn-on. 4. Sink current capability, 1mA to 100mA. 5. Low Reference Pin current.	M, DM

LINFINITY MICROELECTRONICS

SIGNAL CONDITIONING PRODUCTS

Voltage Reference Circuits

Device Type	Description	Page #	Key Features	Packages
LX6431/A/B	PRECISION PROGRAMMABLE REFERENCES.	8-31	1. Unconditionally stable for all cathode to anode capacitance values. 2. Reduced reference input current. (0.5µA max.) 3. Initial voltage reference accuracy of 0.4%. (LX6431B) 4. Sink current capability 0.6mA to 100mA. 5. Typical output dynamic impedance less than 100mΩ. 6. Adjustable output voltage from 2.5V to 36V.	DM LP PK
SG103-xx	VOLTAGE REFERENCE CIRCUIT.	8-43	1. ±10% initial tolerance. (for tighter tolerance contact factory) 2. Bandgap design. 3. Low dynamic impedance from 10µA to 10mA. (improved over LM103) 4. -1mV/°C temperature coefficient. 5. Output voltages: 1.8V, 2.4V, 2.7V, 3.3V, 4.7V, 5.1V. 6. Low capacitance. 7. Performance guaranteed over full military temp. range.	Z
SG1503/2503/3503	2.5V PRECISION VOLTAGE REFERENCE.	8-47	1. Bandgap design. 2. Output voltage trimmed to ±1%. 3. Input voltage range of 4.5V to 40V. 4. Temperature coefficient of 10ppm/°C 5. Output current in excess of 10mA. 6. Interchangeable with MC1503 and AD580.	Y T M DM
TL431/431A/431B	PRECISION PROGRAMMABLE REFERENCES.	8-51	1. Initial voltage reference accuracy of 0.4%. (TL1431) 2. Sink current capability 0.6mA to 100mA. 3. Typical output dynamic impedance < 200mΩ. Typical output dynamic impedance of 1431 < 100mΩ. 4. Adjustable output voltage from 2.5V to 36V. 5. Low output noise. 6. Direct pin-to-pin replacement for industry standard TL431 and TL1431.	DM LP PK

LM385/385B

1.2 & 2.5V Micropower Voltage Reference

PRODUCTION DATA SHEET

DESCRIPTION

The LM385/385B Micropower Voltage References are two terminal bandgap reference diodes designed and optimized for accurate low power operation in portable and other power sensitive systems. Operating currents are guaranteed from as low as 15µA up to 20mA for the LM385/385B-1.2, and 20µA up to 20mA for the LM385/385B-2.5, giving designers a great deal of flexibility in optimizing power consumption, noise and ultimate application performance. As an added feature, the references output impedance is extraordinarily low over the entire operating range of quiescent currents. This enables an extremely wide dynamic load range with little effect on the overall reference accuracy.

The LM385 family is available in fixed 1.2V and 2.5V reference values. Process and circuit design optimization provide for high accuracy with initial tolerance values of 1% for the LM385B-1.2, 2% for the LM385-1.2, 1.5% for the LM385B-2.5, and 3% for the LM385-2.5. Complementing their initial accuracy, the bandgap reference is temperature compensated to deliver 20ppm performance over the 0° to 70°C operating temperature range.

The LM385 family from Linfinity is a pin-for-pin replacement for the LM385/385B family of voltage references.

KEY FEATURES

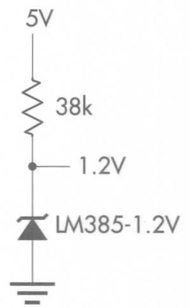
- **GUARANTEED 1% INITIAL ACCURACY (LM385B-1.2)**
- **GUARANTEED 2.5% INITIAL ACCURACY (LM385-1.2)**
- **GUARANTEED 1.5% INITIAL ACCURACY (LM385B-2.5)**
- **GUARANTEED 3% INITIAL ACCURACY (LM385-2.5)**
- GUARANTEED 20µA OPERATING CURRENT
- LOW TEMPERATURE COEFFICIENT
- OPERATING CURRENT OF 20µA TO 20mA
- VERY LOW DYNAMIC IMPEDANCE . . . 1Ω

APPLICATIONS

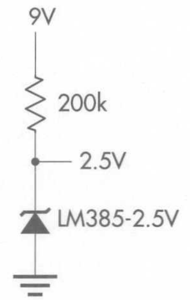
- **PORTABLE METER REFERENCES**
- PORTABLE TEST INSTRUMENTS
- BATTERY OPERATED SYSTEMS
- CURRENT LOOP INSTRUMENTATION

PRODUCT HIGHLIGHT

1.2V Reference



Micropower Reference From 9V Battery



PACKAGE ORDER INFORMATION

T_A (°C)	Reference Voltage	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	1.2V	±30mV	LM385DM-1.2	LM385LP-2.5
		±12mV	LM385DM-1.2	LM385BLP-1.2
	2.5V	±75mV	LM385DM-2.5	LM385LP-2.5
		±38mV	LM385BDM-2.5	LM385BLP-2.5

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LM385DM-2.5T)

LM385/385B

1.2 & 2.5V Micropower Voltage Reference

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Reverse Breakdown Current	30mA
Forward Current	10mA
Operating Temperature Range	
LM385	0°C to 70°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (soldering, 10 seconds)	300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal

THERMAL DATA

DM PACKAGE:

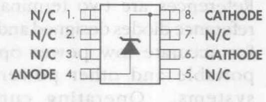
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

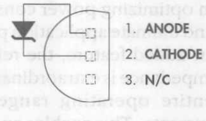
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply to T_A = 25°C. Typ number represents T_A = 25°C value.)

LM385/385B-1.2

Parameter		Symbol	Test Conditions	LM385/385B-1.2			Units
				Min.	Typ.	Max.	
Reverse Breakdown Voltage	LM385	V_Z	$I_{MIN} \leq I_R \leq I_{MAX}$	1.205	1.235	1.260	V
	LM385B		$I_{MIN} \leq I_R \leq I_{MAX}$	1.223	1.235	1.247	V
Average Temperature Coefficient		$\Delta V_Z / \Delta Temp$	I_R = 100µA		20		ppm/°C
Minimum Operating Current		I_{MIN}			8	15	µA
Reverse Breakdown Voltage Chang		e	ΔV_Z $I_{MIN} \leq I_R \leq$ 1mA			1.5	mV
with Current		ΔI_R	1mA $\leq I_R \leq$ 20mA			20	mV
Reverse Dynamic Impedance		r_z	I_R = 100µA		1		Ω
Wide Band Noise (RMS)		e_n	I_R = 100µA, 10Hz $\leq f \leq$ 10kHz		60		µV
Long Term Stability		$\Delta V_Z / \Delta Time$	I_R = 100µA, T_A = 25°C ± 0.1°C		20		ppm/kHr

LM385/385B-2.5

Parameter		Symbol	Test Conditions	LM385/385B-2.5			Units
				Min.	Typ.	Max.	
Reverse Breakdown Voltage	LM385	V_Z	$I_{MIN} \leq I_R \leq I_{MAX}$	2.425	2.500	2.575	V
	LM385B		$I_{MIN} \leq I_R \leq I_{MAX}$	2.462	2.500	2.538	V
Average Temperature Coefficient		$\Delta V_Z / \Delta Temp$	I_R = 100µA		20		ppm/°C
Minimum Operating Current		I_{MIN}			13	20	µA
Reverse Breakdown Voltage Chang		e	ΔV_Z $I_{MIN} \leq I_R \leq$ 1mA			2	mV
with Current		ΔI_R	1mA $\leq I_R \leq$ 20mA			20	mV
Reverse Dynamic Impedance		r_z	I_R = 100µA, f = 20Hz		1		Ω
Wide Band Noise (RMS)		e_n	I_R = 100µA, 10Hz $\leq f \leq$ 10kHz		120		µV
Long Term Stability		$\Delta V_Z / \Delta Time$	I_R = 100µA, T_A = 25°C ± 0.1°C		20		ppm/kHr

GRAPH / CURVE INDEX

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES — LM385/385B-1.2V

FIGURE 1. — RESPONSE TIME

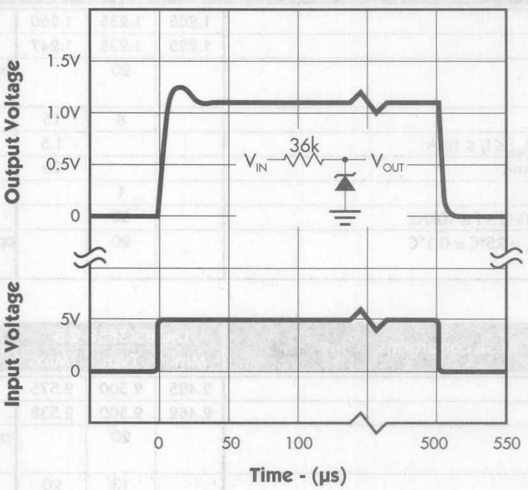


FIGURE 2. — REVERSE CHARACTERISTICS

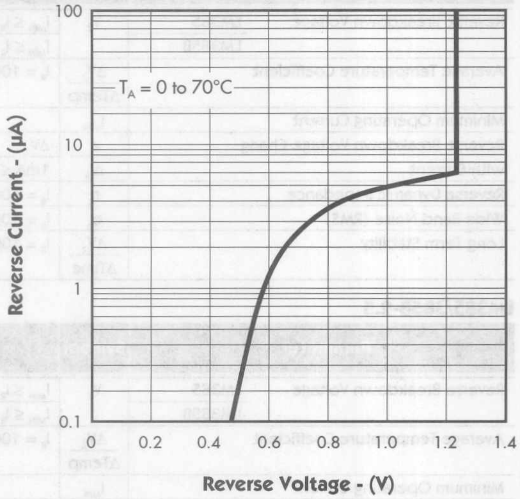


FIGURE 3. — FORWARD CHARACTERISTICS

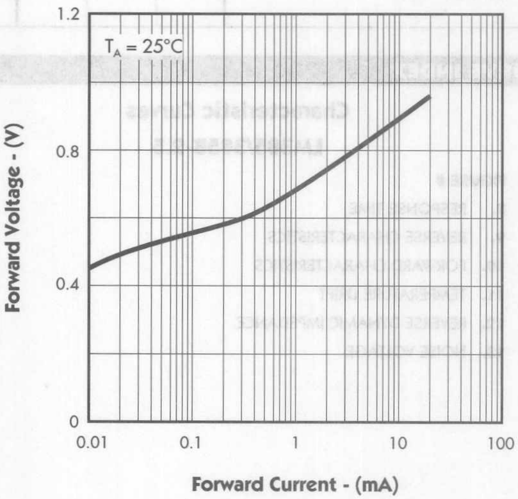
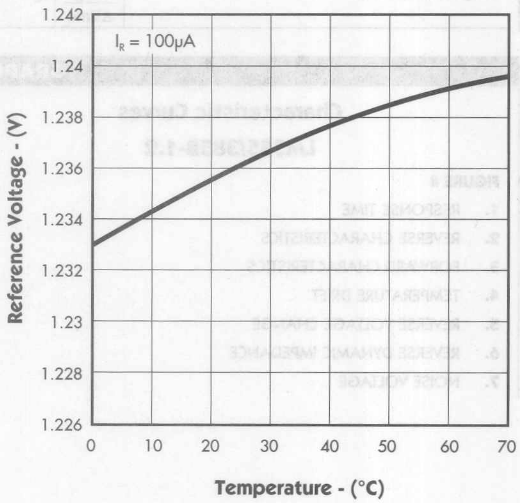


FIGURE 4. — TEMPERATURE DRIFT



CHARACTERISTIC CURVES — LM385/385B-1.2V

FIGURE 5. — REVERSE VOLTAGE CHANGE

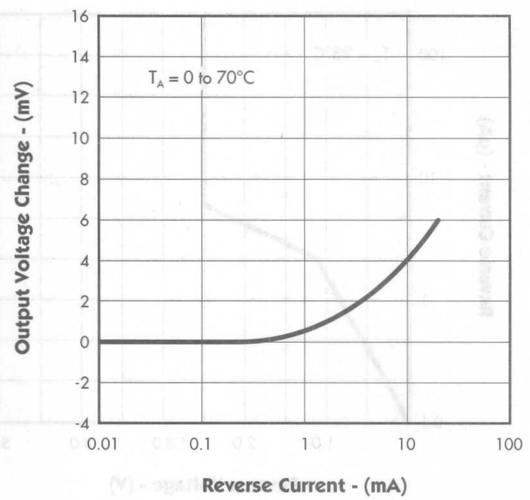


FIGURE 6. — REVERSE DYNAMIC IMPEDANCE

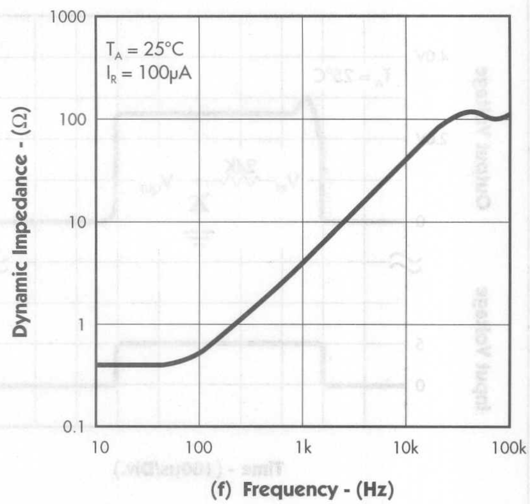
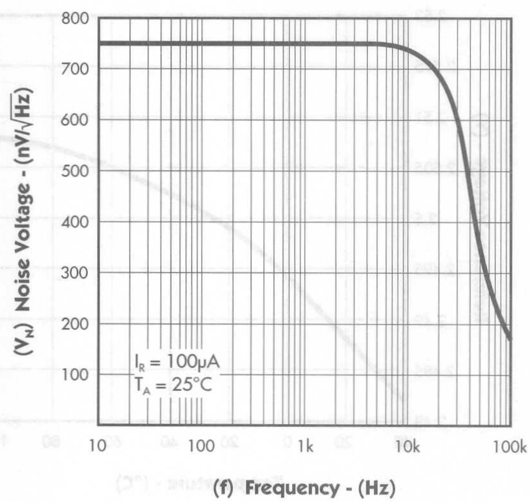


FIGURE 7. — NOISE VOLTAGE



CHARACTERISTIC CURVES — LM385/385B-2.5V

FIGURE 8. — RESPONSE TIME

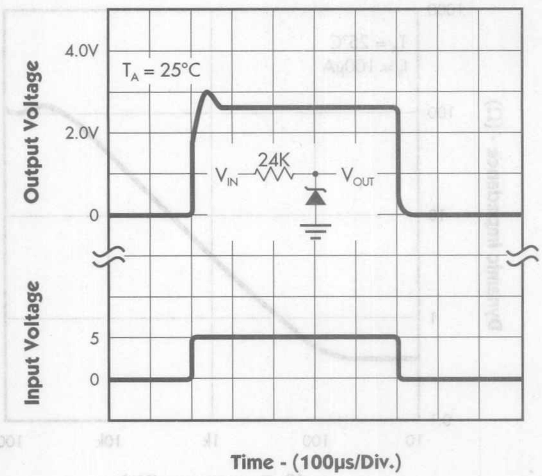


FIGURE 9. — REVERSE CHARACTERISTICS

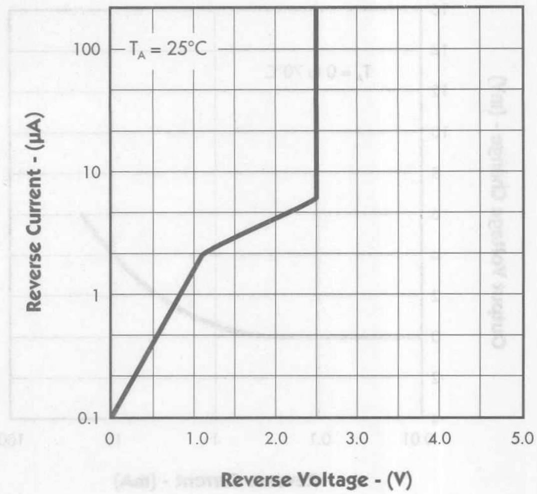


FIGURE 10. — FORWARD CHARACTERISTICS

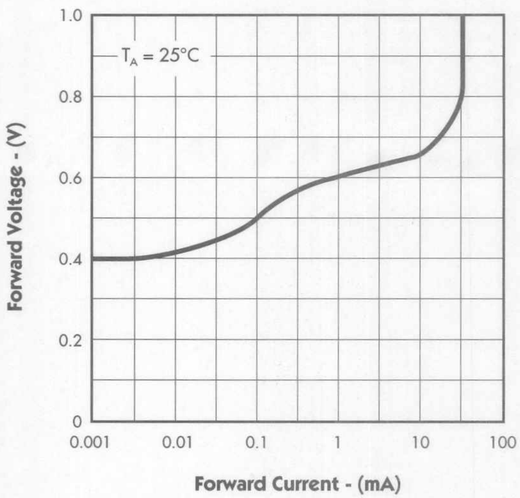
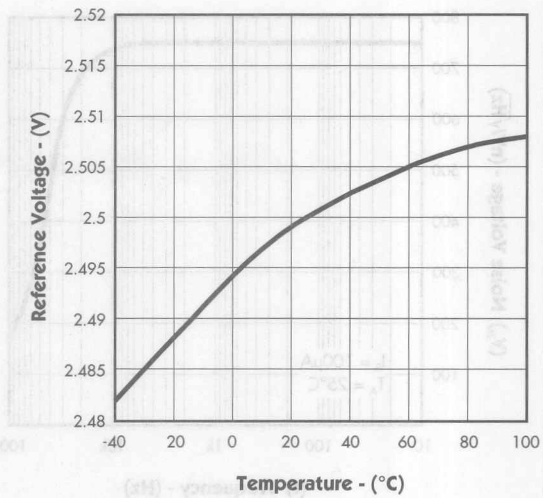


FIGURE 11. — TEMPERATURE DRIFT



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES — LM385/385B-2.5V

FIGURE 12. — REVERSE DYNAMIC IMPEDANCE

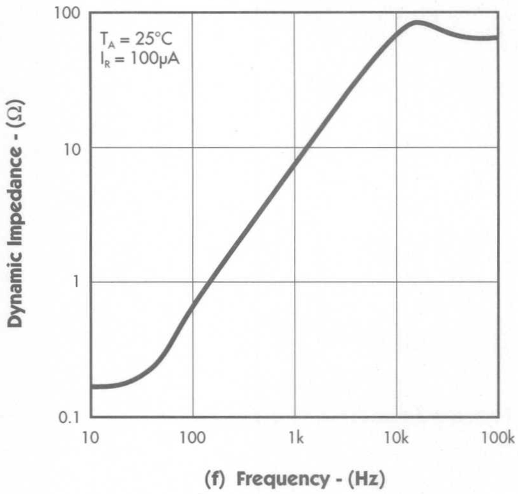
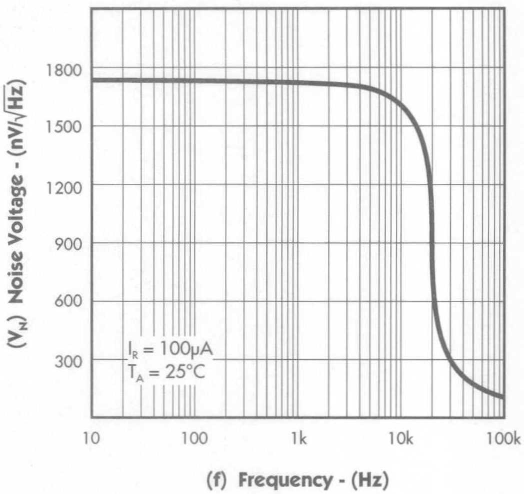


FIGURE 13. — NOISE VOLTAGE



Notes

DESCRIPTION

The LX1004 Micropower Voltage References are two terminal bandgap reference diodes designed and optimized for accurate low power operation in portable and other power sensitive systems. Operating currents are guaranteed from as low as 10µA up to 20mA giving designers a great deal of flexibility in optimizing power consumption, noise and ultimate application performance.

The LX1004 is available in fixed 1.2V and 2.5V reference values.

Process and circuit design optimization provide for high accuracy with initial tolerance values of ±4mV and ±20mV, respectively. Complementing their initial accuracy, the bandgap reference is temperature compensated to deliver 20ppm performance over the 0° to 70°C operating temperature range.

The LX1004 from Linfinity is a pin-for-pin replacement for the LT1004 and LM385 families of voltage references.

KEY FEATURES

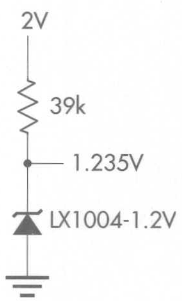
- **GUARANTEED ±4mV INITIAL ACCURACY LX1004-1.2**
- **GUARANTEED ±20mV INITIAL ACCURACY LX1004-2.5**
- GUARANTEED 10µA OPERATING CURRENT
- GUARANTEED TEMPERATURE PERFORMANCE
- OPERATES UP TO 20mA
- VERY LOW DYNAMIC IMPEDANCE

APPLICATIONS

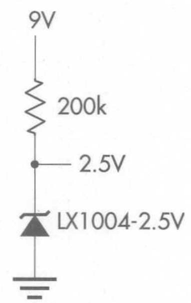
- **PORTABLE METER REFERENCES**
- PORTABLE TEST INSTRUMENTS
- BATTERY OPERATED SYSTEMS
- CURRENT LOOP INSTRUMENTATION

PRODUCT HIGHLIGHT

MICROPOWER REFERENCE FROM 2 CELL BATTERY



MICROPOWER REFERENCE FROM 9V BATTERY



PACKAGE ORDER INFORMATION

T_A (°C)	Reference Voltage	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	1.2V	±4mV	LX1004CDM-1.2	LX1004CLP-1.2
	2.5V	±20mV	LX1004CDM-2.5	LX1004CLP-2.5

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1004CDM-2.5T)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX1004

1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Reverse Breakdown Current	30mA
Forward Current	10mA
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (soldering, 10 seconds)	300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal

THERMAL DATA

DM PACKAGE:

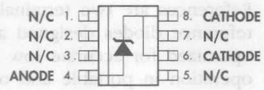
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

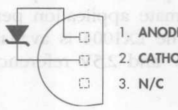
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

1.2V & 2.5V Micropower Voltage References

Production Data Sheet

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply to T_A = 25°C for LX1004C. Typ. number represents T_A = 25°C value.

LX1004 - 1.2

Parameter	Symbol	Test Conditions	LX1004 - 1.2 Min.	Typ.	Max.	Units
Reverse Breakdown Voltage	V_Z	I_R = 100µA, T_A = 25°C	1.231	1.235	1.239	V
		0°≤ T_A ≤ 70°C	1.225	1.235	1.245	V
Average Temperature Coefficient	ΔV_Z / ΔTemp	$I_{MIN} \le I_R \le$ 20mA		20		ppm/°C
Minimum Operating Current	I_{MIN}	0°≤ T_A ≤ 70°C		8	10	µA
Reverse Breakdown Voltage Change with Current	ΔV_Z / ΔI_R	$I_{MIN} \le I_R \le$ 1mA, T_A = 25°C			1	mV
		$I_{MIN} \le I_R \le$ 1mA, 0° ≤ T_A ≤ 70°C			1.5	mV
		1mA ≤ I_R ≤ 20mA, T_A = 25°C			10	mV
		1mA ≤ I_R ≤ 20mA, 0° ≤ T_A ≤ 70°C			20	mV
Reverse Dynamic Impedance	r_z	I_R = 100µA, T_A = 25°C		0.2	0.6	Ω
		I_R = 100µA, 0° ≤ T_A ≤ 70°C			1.5	Ω
Wide Band Noise (RMS)	e_n	I_R = 100µA; 10Hz ≤ f ≤ 10kHz		60		µV
Long Term Stability	ΔV_Z / ΔTime	I_R = 100µA; T_A = 25°C ± 0.1°C		20		ppm/kHr

LX1004 - 2.5

Parameter	Symbol	Test Conditions	LX1004 - 2.5 Min.	Typ.	Max.	Units
Reverse Breakdown Voltage	V_Z	I_R = 100µA, T_A = 25°C	2.480	2.500	2.520	V
		0°≤ T_A ≤ 70°C	2.470		2.530	V
Average Temperature Coefficient	ΔV_Z / ΔTemp	$I_{MIN} \le I_R \le$ 20mA		20		ppm/°C
Minimum Operating Current	I_{MIN}	0°≤ T_A ≤ 70°C		12	20	µA
Reverse Breakdown Voltage Change with Current	ΔV_Z / ΔI_R	$I_{MIN} \le I_R \le$ 1mA, T_A = 25°C			1	mV
		$I_{MIN} \le I_R \le$ 1mA, 0° ≤ T_A ≤ 70°C			1.5	mV
		1mA ≤ I_R ≤ 20mA, T_A = 25°C			10	mV
		1mA ≤ I_R ≤ 20mA, 0° ≤ T_A ≤ 70°C			20	mV
Reverse Dynamic Impedance	r_z	I_R = 100µA, T_A = 25°C		0.2	0.6	Ω
		I_R = 100µA, 0° ≤ T_A ≤ 70°C			1.5	Ω
Wide Band Noise (RMS)	e_n	I_R = 100µA; 10Hz ≤ f ≤ 10kHz		120		µV
Long Term Stability	ΔV_Z / ΔTime	I_R = 100µA; T_A = 25°C ± 0.1°C		20		ppm/kHr

GRAPH / CURVE INDEX

Characteristic Curves — LX1004-1.2V

FIGURE #

Characteristic Curves — LX1004-2.5V

FIGURE #

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES — LX1004-1.2V

FIGURE 1. — TEMPERATURE DRIFT

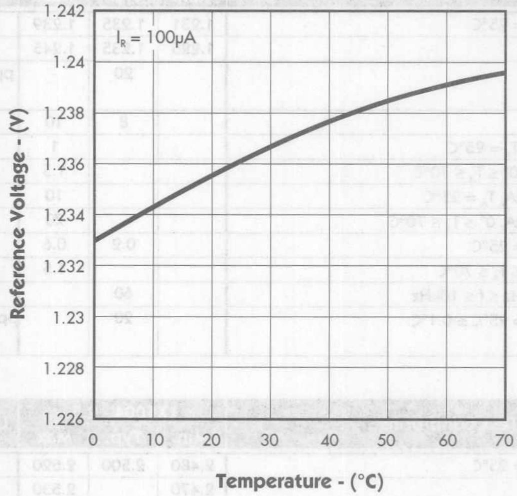


FIGURE 2. — REVERSE CHARACTERISTICS

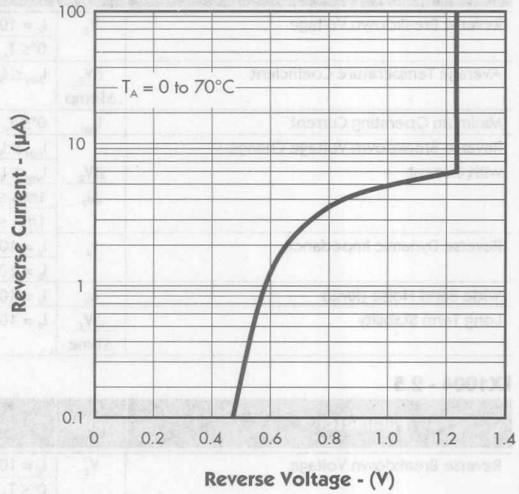


FIGURE 3. — REVERSE VOLTAGE CHANGE

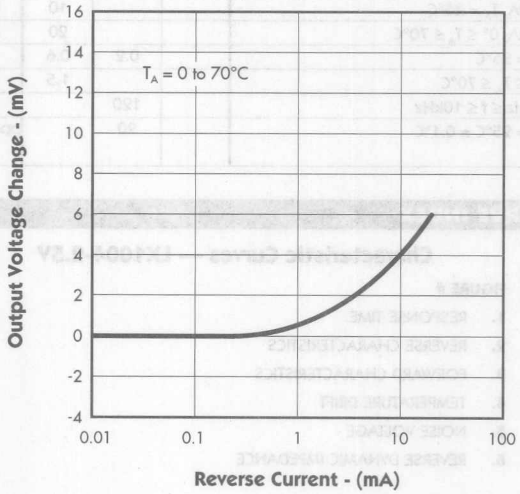
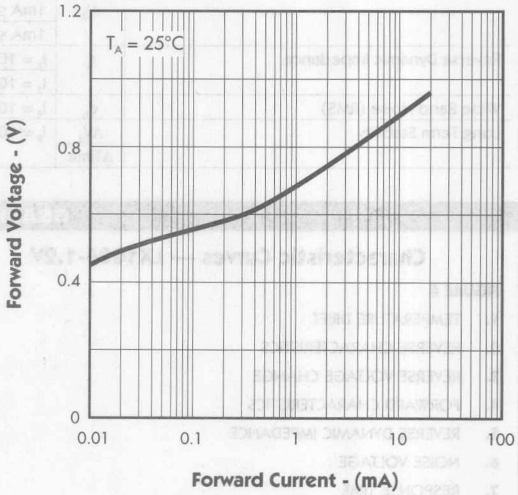


FIGURE 4. — FORWARD CHARACTERISTICS



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES — LX1004-1.2V

FIGURE 5. — REVERSE DYNAMIC IMPEDANCE

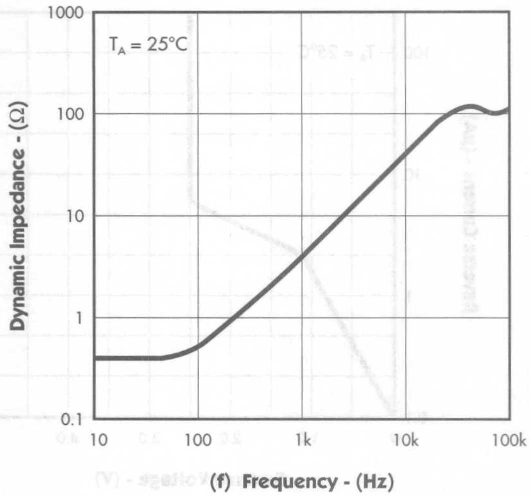


FIGURE 6. — NOISE VOLTAGE

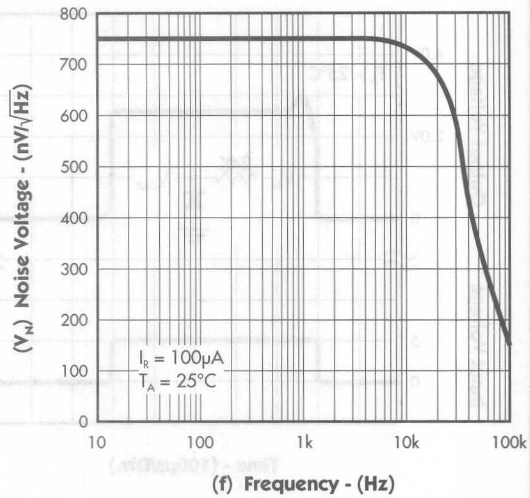
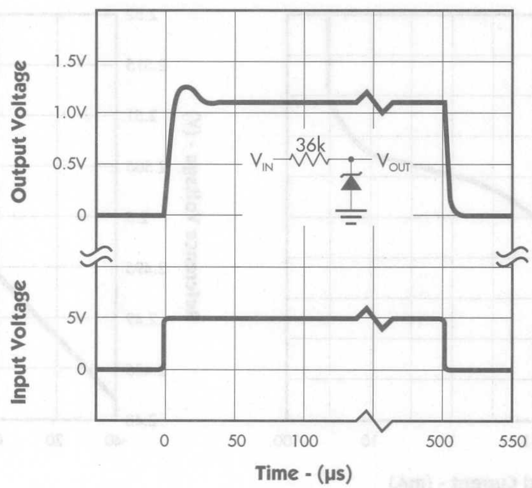


FIGURE 7. — RESPONSE TIME



LINFINITY
MICROELECTRONICS

CHARACTERISTIC CURVES — LX1004-2.5V

FIGURE 8. — RESPONSE TIME

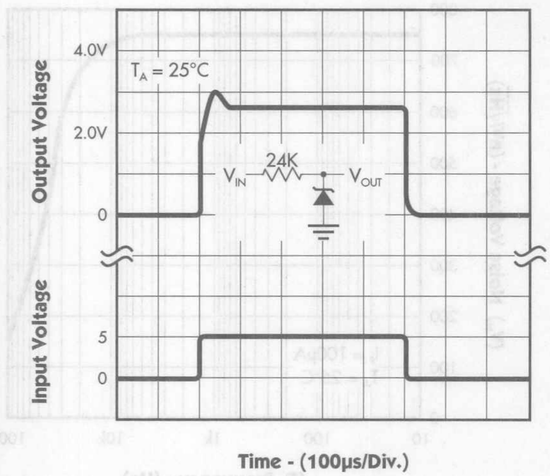


FIGURE 9. — REVERSE CHARACTERISTICS

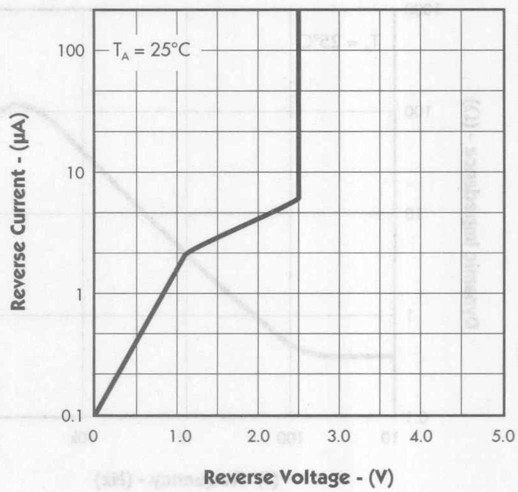


FIGURE 10. — FORWARD CHARACTERISTICS

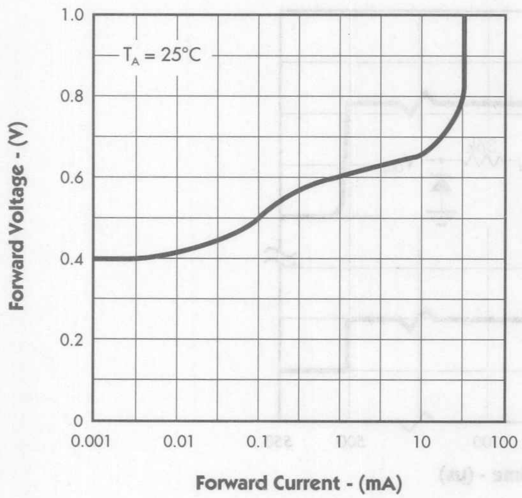
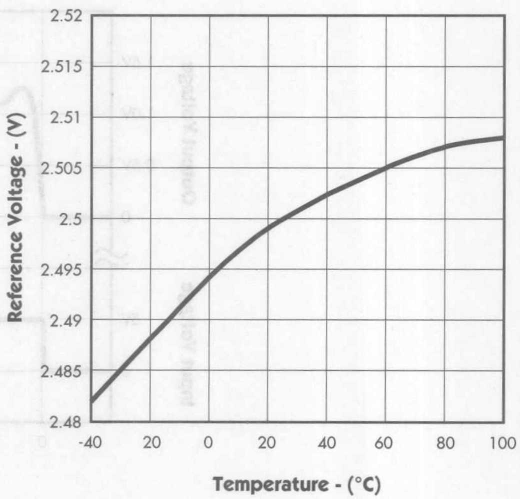


FIGURE 11. — TEMPERATURE DRIFT



CHARACTERISTIC CURVES — LX1004-2.5V

FIGURE 12. — NOISE VOLTAGE

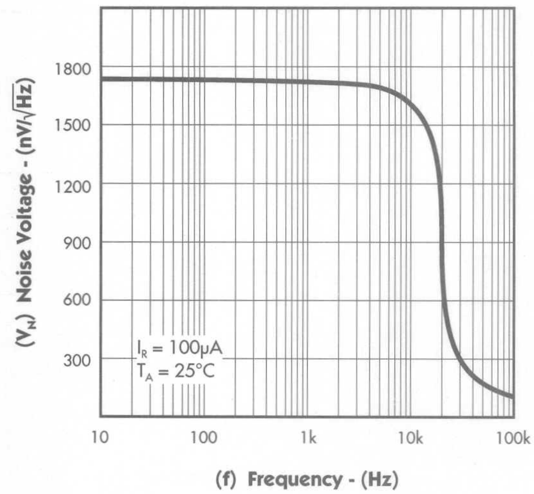
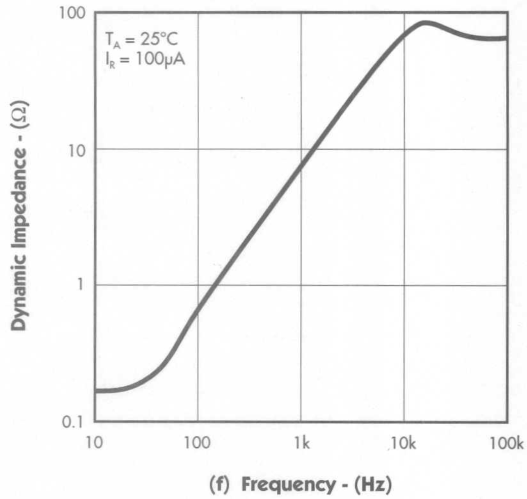


FIGURE 13. — REVERSE DYNAMIC IMPEDANCE



LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX1431

PROGRAMMABLE REFERENCE

PRODUCTION DATA SHEET

DESCRIPTION

The LX1431 is an adjustable shunt voltage regulator featuring 100mA sink capability, a 0.4% initial reference voltage tolerance and a 0.3% typical temperature stability. This product, which is ideal for use in Pentium® applications, is equipped with on-chip divider resistors, enabling it to be configured as a 5V shunt regulator. In this configuration, the LX1431 has an initial voltage tolerance of *only* 1% and requires no additional external components. The Linfinity LX1431EB evaluation board and design kit is available to assist engineers in quickly configuring the most efficient, cost-effective Pentium designs.

The output voltage of the LX1431 may be set to any value between 2.5V and 36V through the addition of two external resistors, which is of particular importance in the design of both adjustable and switching power supplies. In addition, the nominal internal current limit of 100mA may be decreased with the addition of a single external resistor.

For applications requiring an adjustable reference, the Linfinity LX6431CLP, a simplified three-pin programmable reference, may be used. Because the LX6431 is pin-for-pin compatible with Linfinity's earlier TL431, use of this product provides designers a simple migration path to the more robust LX6431. A separate LX6431 data sheet is available which details the specifics of this product.

In addition, Pentium designers may use Linfinity's LX8585/8585A 4.6A or LX8584/8584A 7A Low Dropout Regulators to achieve the most optimum motherboard configuration.

KEY FEATURES

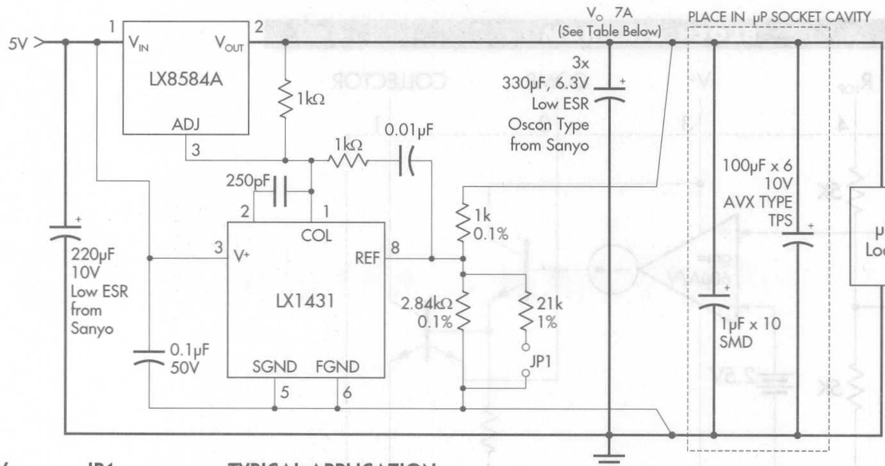
- GUARANTEED 0.4% INITIAL VOLTAGE TOLERANCE
- 0.1Ω TYPICAL DYNAMIC OUTPUT IMPEDANCE
- FAST TURN-ON
- SINK CURRENT CAPABILITY, 1mA TO 100mA
- LOW REFERENCE PIN CURRENT

APPLICATIONS

- LINEAR REGULATORS
- ADJUSTABLE POWER SUPPLIES
- SWITCHING POWER SUPPLIES
- LX1431EB EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

PRODUCT HIGHLIGHT

THE LX8584A AND LX1431 IN 75 AND 166MHz P54C PROCESSOR APPLICATIONS USING 3.3V CACHE



V_O	JP1	TYPICAL APPLICATION
3.50	Short	120/166MHz, VRE, 3.3V Cache
3.38	Open	75/90/100/133MHz, STND, 3.3V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
0 to 70	LX1431CM	LX1431CDM
-40 to 85	LX1431IM	LX1431IDM

Note: All surface mount packages are available in Tape & Reel. Append the letter "T" to part number (i.e. LX1431CDMT).

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX1431

PROGRAMMABLE REFERENCE

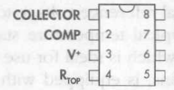
PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

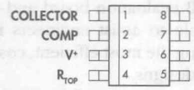
V^+, $V_{COLLECTOR}$	36V
V_{COMP}, R_{TOP}, R_{MID}, V_{REF}	6V
GND-F to GND-S	0.7V
Operating Junction Temperature	
Plastic (M, DM Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

PACKAGE PIN OUTS



M PACKAGE
(Top View)



DM PACKAGE
(Top View)

THERMAL DATA

M PACKAGE:

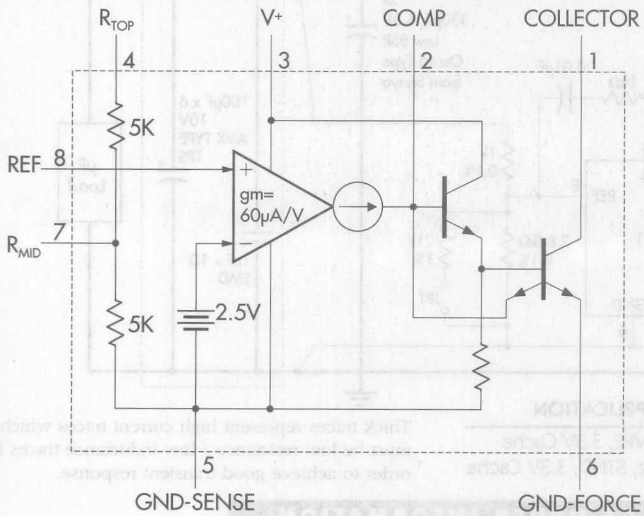
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	95°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow.

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX1431C with 0°C ≤ T_A ≤ 70°C, LX1431I with -40°C ≤ T_A ≤ 85°C.)

Parameter	Symbol	Test Conditions	LX1431I			LX1431C			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Voltage	V_{REF}	V_{KA} = 5V, I_K = 2mA, T_A = 25°C	2490	2500	2510	2490	2500	2510	mV
		V_{KA} = 5V, I_K = 2mA	2465		2535	2480		2520	mV
Reference Drift	$\Delta V_{REF}/\Delta T$	V_{KA} = 5V, I_K = 2mA		50			30		ppm/°C
Voltage Ratio, Reference to Cathode (Open Loop Gain)	ΔV_{REF} / ΔV_{KA}	I_K = 2mA, V_{KA} = 3V to 36V		0.2	1.0		0.2	1.0	mV/V
Reference Input Current	$[I_{REF}]$	V_{KA} = 5V, T_A = 25°C		0.2	1		0.2	1	µA
		V_{KA} = 5V			1.5			1.2	µA
Minimum Operating Current	I_{MIN}	V_{KA} = V_{REF} to 36V, T_A = 25°C		0.6	1		0.6	1	mA
Off-State Cathode Current	$[I_{OFF}]$	V_{KA} = 36V, V_{REF} = 0V, T_A = 25°C			1			1	µA
		V_{KA} = 36V, V_{REF} = 0V			15			2	µA
Off-State Collector Leakage Current	$[I_{LEAK}]$	V_{COLL} = 36V, V^+ = 5V, V_{REF} = 2.4V, T_A = 25°C			1			1	µA
		V_{COLL} = 36V, V^+ = 5V, V_{REF} = 2.4V			5			2	µA
Dynamic Impedance	$[Z_{KA}]$	V_{KA} = V_{REF}, I_K = 1mA to 100mA, f ≤ 1kHz, T_A = 25°C			0.1			0.1	Ω
Collector Current Limit	I_{LIM}	V_{KA} = V_{REF} + 50mV	80		360	100		360	mA
5V Reference Output		Internal Divider Used, I_K = 2mA, T_A = +25°C	4950	5000	5050	4950	5000	5050	mV

APPLICATION INFORMATION

PIN FUNCTIONS

Pin 1 COLL: Open collector of the output transistor. The maximum pin voltage is 36V. The saturation voltage at 100mA is approximately 1V.

Pin 2 COMP: Base of the driver for the output transistor. This pin allows additional compensation for complex feedback systems and shutdown of the regulator. It must be left open if unused.

Pin 3 V^+: Bias voltage for the entire shunt regulator. The maximum input voltage is 36V and the minimum to operate is equal to V_{REF} (2.5V). The quiescent current is typically 0.6mA.

Pin 4 R_{TOP}: Top of the on-chip 5k-5k resistive divider that guarantees 1% accuracy of operation as a 5V shunt regulator with no external trim. The pin is tied to COLL for self-contained 5V operation. It may be left open if unused.

Pin 5 GND-S: Ground reference for the on-chip resistive divider and shunt regulator circuitry except for the output transistor. This pin allows external current limit of the output transistor with one resistor between GND-F (force) and GND-S (sense).

Pin 6 GND-F: Emitter of the output transistor and substrate connection for the die.

Pin 7 R_{MID}: Middle of the on-chip resistive divider string between R_{TOP} and GND-S. The pin is tied to REF for self-contained 5V operation. It may be left open if unused.

Pin 8 REF: Control pin of the shunt regulator with a 2.5V threshold.

COMP, R_{TOP}, R_{MID}, and REF have static discharge protection circuits that must not be activated on a continuous basis. Therefore, the absolute maximum DC voltage on these pins is 6V, well beyond the normal operating conditions.

As with all bipolar ICs, the LX1431 contains parasitic diodes which must not be forward biased or else anomalous behavior will result. Pin conditions to be avoided are RTOP below RMID in voltage and any pin below GND-F in voltage (except for GND-S).

FREQUENCY COMPENSATION

Excess capacitance on the REF pin can introduce enough phase shift to induce oscillation when configured as a reference >2.5V. This can be compensated with capacitance between COLL and REF (phase lead). More complicated feedback loops may require shaping of the frequency response of the LX1431 with dominant pole or pole-zero compensation. This can be accomplished with a capacitor or series resistor and capacitor between COLL and COMP.

The compensation schemes mentioned above use voltage feedback to stabilize the circuits. There must be voltage gain at the COLL pin for them to be effective, so the COLL pin must see a reasonable AC impedance. Capacitive loading of the COLL pin reduces the AC impedance, voltage gain, and frequency response, thereby decreasing the effectiveness of the compensation schemes, but also decreasing their necessity.

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

CHARACTERISTIC CURVES

FIGURE 1. — COLLECTOR V_{SAT} vs. TEMPERATURE vs. CURRENT

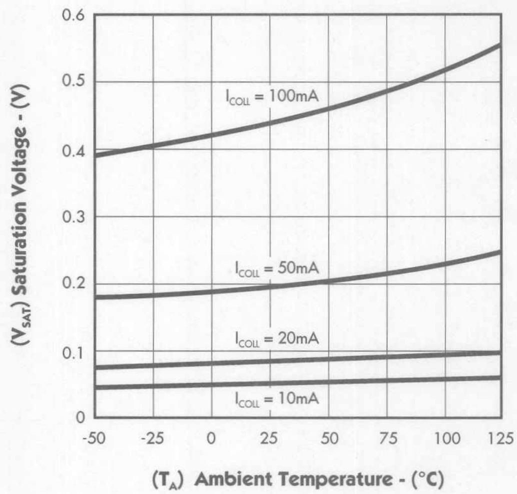


FIGURE 2. — COMPENSATION PIN VOLTAGE vs. TEMPERATURE vs. I_{COLL}

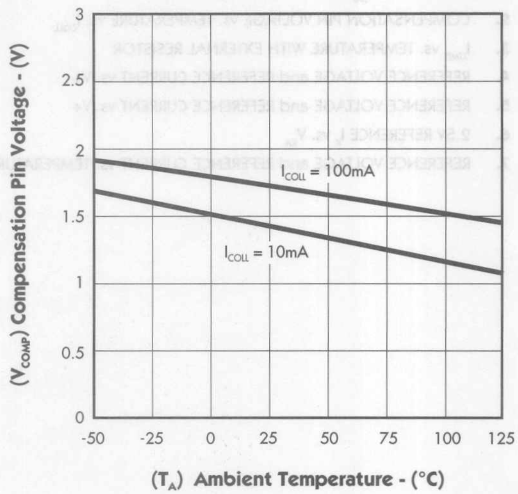


FIGURE 3. — I_{LIMIT} vs. TEMPERATURE WITH EXTERNAL RESISTOR

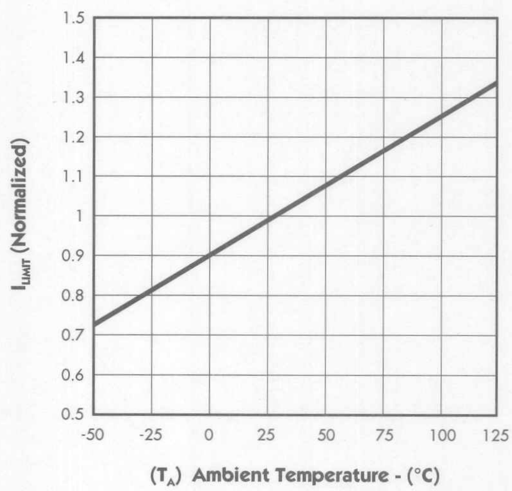
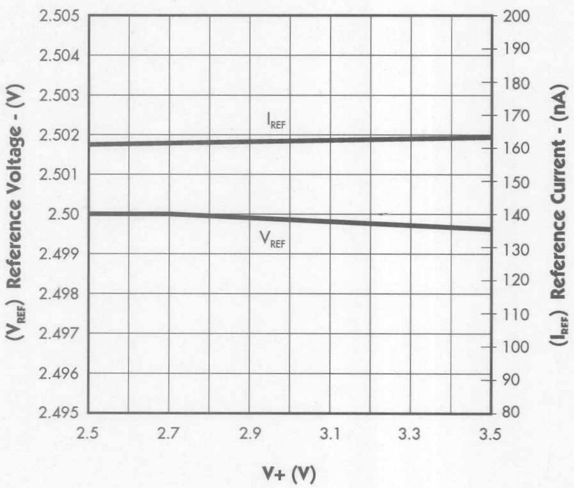


FIGURE 4. — REFERENCE VOLTAGE and REFERENCE CURRENT vs. V+



LINFINITY
MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — REFERENCE VOLTAGE and REFERENCE CURRENT vs. V+

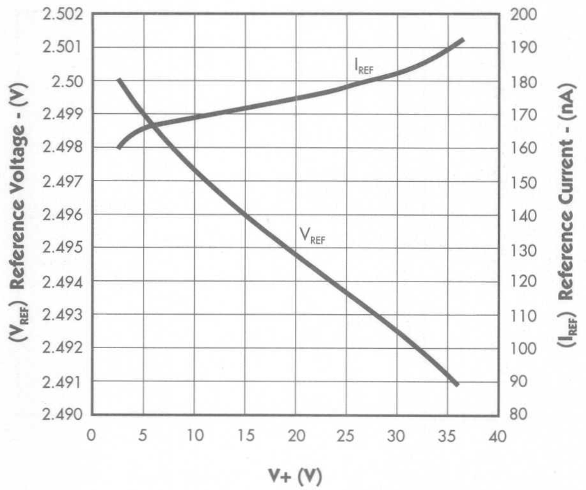


FIGURE 6. — 2.5V REFERENCE I_K vs. V_{KA}

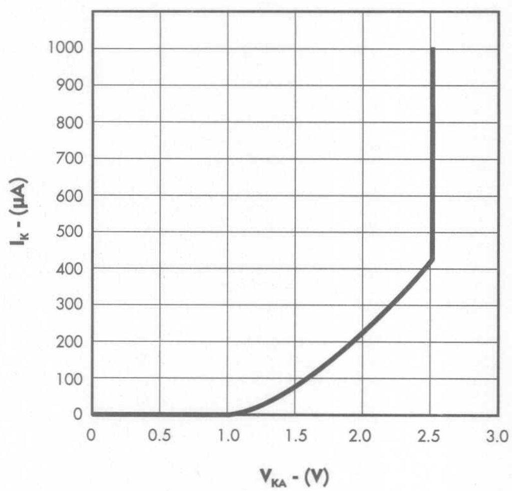
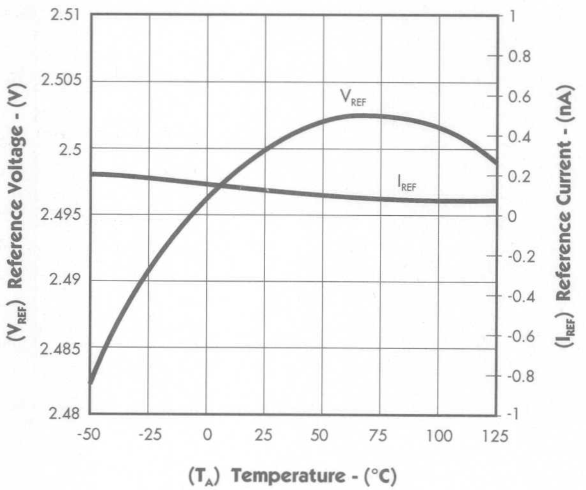


FIGURE 6. — REFERENCE VOLTAGE and REFERENCE CURRENT vs. TEMPERATURE



LIN Doc #: 6431

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX6431/LX6431A/LX6431B

PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

DESCRIPTION

The LX6431 series precision adjustable three terminal shunt voltage regulators are pin-to-pin compatible with the industry standard TL431, but with significant improvements. The LX6431 design has eliminated regions of instability common to older generation shunt regulator products like the TL431. Designs are made simpler by eliminating the task of insuring capacitive loads, and output voltage and cathode currents don't combine for unstable operation. The capacitor value is chosen simply to give the best load transient response without the possibility of instability. A lower reference input current allows the use of higher value reference divider resistors, reducing the current drain from batteries in portable equipment as well as reducing the voltage programming errors due to the impedance of the divider network (See Product Highlight figure below). In addition, the LX6431B has an improved initial accuracy of 0.4%, and the output voltage is programmable by using two external resistors from 2.5V to 36V.

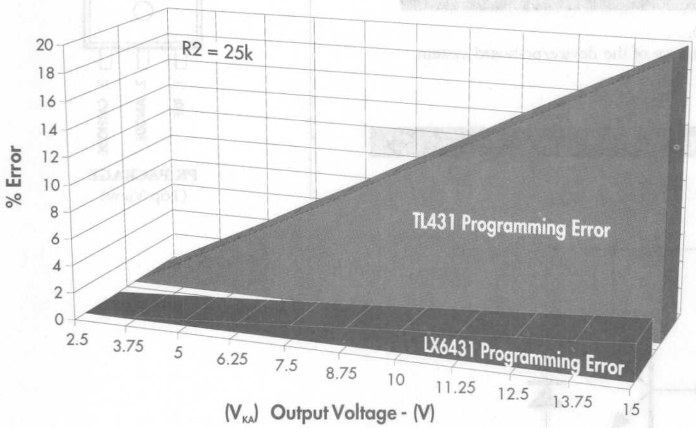
These devices offer low output impedance for improved load regulation. The typical output impedance of these devices is 100mΩ. The reduced reference input bias current and minimum operating currents make these devices suitable for portable and micropower applications.

KEY FEATURES

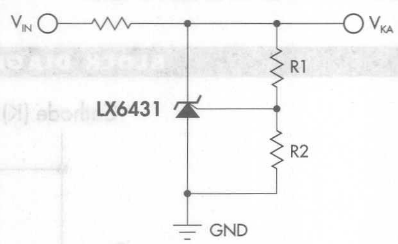
- ■ UNCONDITIONALLY STABLE FOR ALL CATHODE TO ANODE CAPACITANCE VALUES
- ■ REDUCED REFERENCE INPUT CURRENT ALLOWING THE USE OF HIGHER VALUE DIVIDER RESISTORS (0.5µA max.)
- ■ INITIAL VOLTAGE REFERENCE ACCURACY OF 0.4% (LX6431B)
- ■ SINK CURRENT CAPABILITY 0.6mA to 100mA
- ■ TYPICAL OUTPUT DYNAMIC IMPEDANCE LESS THAN 100mΩ
- □ ADJUSTABLE OUTPUT VOLTAGE FROM 2.5V TO 36V

PRODUCT HIGHLIGHT

OUTPUT VOLTAGE ERROR DUE TO I_{REF}



TYPICAL PROGRAMMABLE VOLTAGE REFERENCE CIRCUIT



PACKAGE ORDER INFORMATION

T_A (°C)	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	2%	LX6431CDM	LX6431CLP	LX6431CPK
	1%	LX6431ACDM	LX6431ACLP	LX6431ACPK
	0.4%	LX6431BCDM	LX6431BCLP	LX6431BCPK
-40 to 85	2%	LX6431IDM	LX6431ILP	LX6431IPK
	1%	LX6431AIDM	LX6431AILP	LX6431AIPK
	0.4%	LX6431BIDM	LX6431BILP	LX6431BIPK

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5212CDPT) TO-92 (LP) package also available in ammo-pack.

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX6431/LX6431A/LX6431B

Precision Programmable References

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Cathode to Anode Voltage (V_{KA}) .... -0.3V to 37V
Reference Input Current (I_{REF}) .... -50µA to 10µA
Continuous Cathode Current (I_K) .... -100mA to 150mA
Operating Junction Temperature
Plastic (DM, LP & PK Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

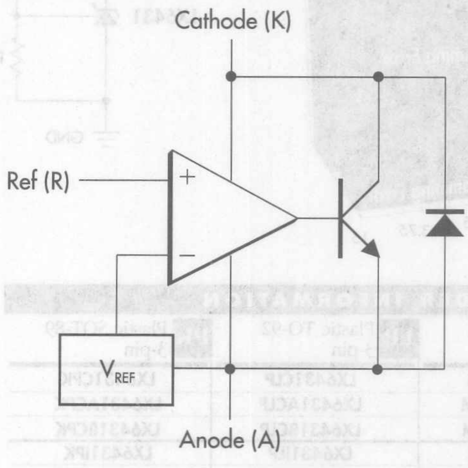
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

PK PACKAGE:

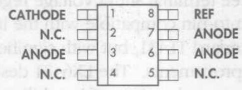
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	71°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

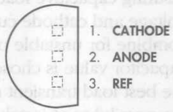
BLOCK DIAGRAM



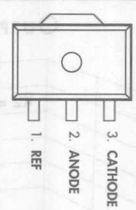
PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)



PK PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS (Note 2)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX6431C/LX6431AC/LX6431BC with 0°C ≤ T_A ≤ 70°C, LX6431I/LX6431AI/LX6431BI with -40°C ≤ T_A ≤ 85°C.)

Parameter		Symbol	Test Conditions	LX6431 Min.	LX6431 Typ.	LX6431 Max.	Units
Reference Input Voltage	LX6431	V_{REF}	I_K = 10mA, V_{KA} = V_{REF}, T_A = 25°C,	2440		2550	mV
	LX6431A		I_K = 10mA, V_{KA} = V_{REF}, T_A = 25°C	2470		2520	mV
	LX6431B		I_K = 10mA, V_{KA} = V_{REF}, T_A = 25°C	2490		2510	mV
Reference Drift	LX6431		I_K = 10mA, V_{KA} = V_{REF}, 0°C ≤ T_A ≤ 70°C			15	mV
			I_K = 10mA, V_{KA} = V_{REF}, -40°C ≤ T_A ≤ 85°C			25	mV
	LX6431A		I_K = 10mA, V_{KA} = V_{REF}, 0°C ≤ T_A ≤ 70°C			15	mV
			I_K = 10mA, V_{KA} = V_{REF}, -40°C ≤ T_A ≤ 85°C			25	mV
	LX6431B		I_K = 10mA, V_{KA} = V_{REF}, 0°C ≤ T_A ≤ 70°C			15	mV
			I_K = 10mA, V_{KA} = V_{REF}, -40°C ≤ T_A ≤ 85°C			20	mV
Voltage Ratio, Reference to Cathode (Note 3)			I_K = 10mA, V_{KA} = 2.5V to 36V, T_A = 25°C		0.3	1	mV/V
			I_K = 10mA, V_{KA} = 2.5V to 36V, T_A = Operating Range		0.3	1	mV/V
Reference Input Current		I_{REF}	V_{KA} = V_{REF}, T_A = 25°C		0.1	0.5	µA
			V_{KA} = V_{REF}, T_A = Operating Range		0.1	0.5	µA
Minimum Operating Current		I_{MIN}	V_{KA} = V_{REF} to 36V, T_A = 25°C		0.4	0.6	mA
			V_{KA} = V_{REF} to 36V, T_A = Operating Range		0.4	0.6	mA
Off-State Cathode Current		I_{OFF}	V_{KA} = 36V, V_{REF} = 0V, T_A = 25°C		0.3	1	µA
Dynamic Impedance		Z_{KA}	V_{KA} = V_{REF}, I_K = 0.6mA to 100mA, f ≤ 1kHz, T_A = 25°C		30	100	mΩ

Note 2. These parameters are guaranteed by design.

Note 3. $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of change in reference input voltage to the change in cathode voltage.

LINFINITY MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Information

Parameter Measurement Information

Typical Characteristics

CHARACTERISTIC CURVES

FIGURE 1. — REFERENCE VOLTAGE vs. FREE-AIR TEMPERATURE

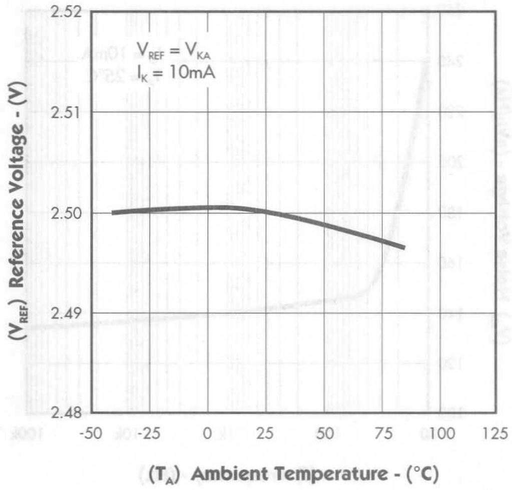


FIGURE 2. — REFERENCE CURRENT vs. FREE-AIR TEMPERATURE

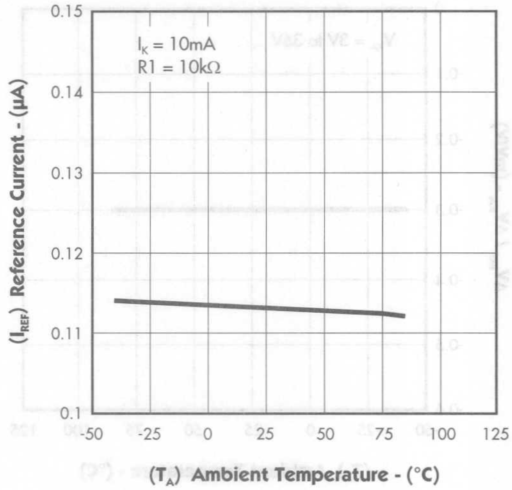


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

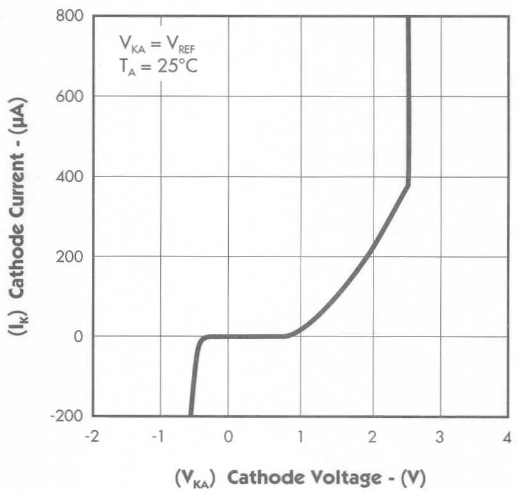
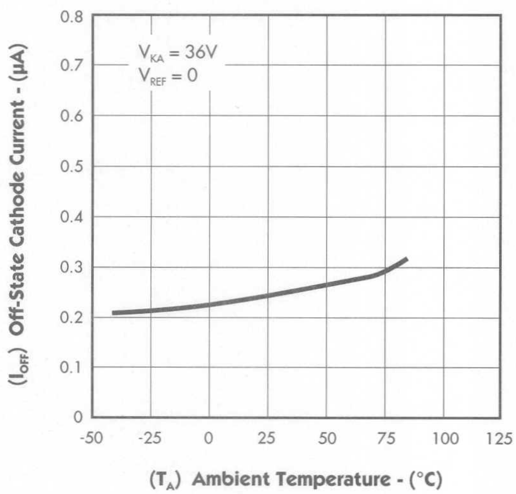


FIGURE 4. — OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE



CHARACTERISTIC CURVES

FIGURE 5. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

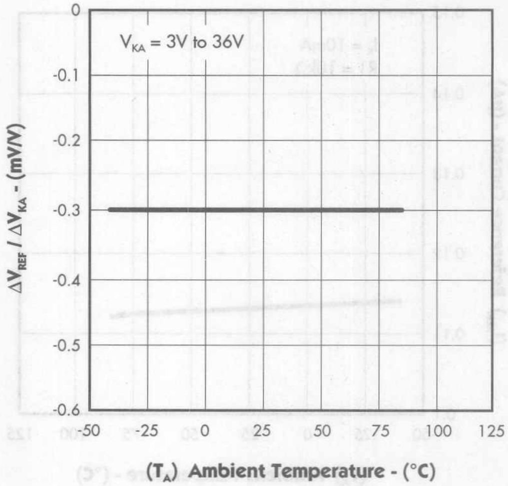
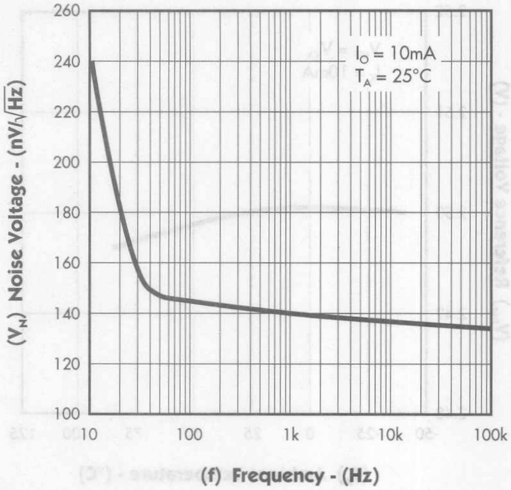


FIGURE 6. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY



LINFINITY MICROELECTRONICS

APPLICATION INFORMATION

Application Hints

The reference input current of the LX6431 series voltage references is much lower than other similar precision parts. This helps to design programmable voltage references that can use much higher value programming resistors while maintaining the same accuracy as the other precision parts. Figure 7 below shows a 5V, 1% shunt regulator using the LX6431B and a shunt regulator using the TL1431 (Also available from Linfinity). Figure 8 shows 0.5% shunt regulators. Noteworthy are the values of the reference resistors used in the two circuits. With the LX6431B it is possible to use 25k resistors for setting the output voltage with 1% precision as opposed to 5k programming resistors when the same precision needs to be achieved with a TL1431.

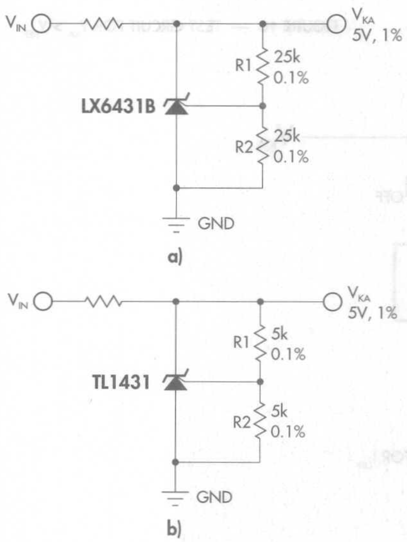


FIGURE 7 — Comparison of reference resistor values between an LX6431B and an TL1431, resistors used with the LX6431B are 5 times higher in value.

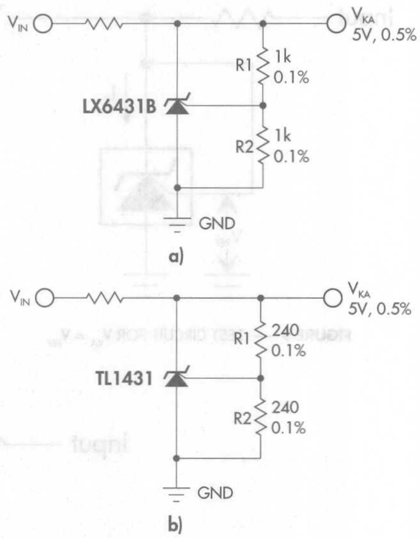


FIGURE 8 — Comparison of reference resistor values between an LX6431B and a TL1431, when used as 0.5%, 5V shunt regulators.

The output voltage of the reference can be programmed by using the formula below:

$$V_{KA} \cong 2.5 * \left(1 + \frac{R1}{R2}\right)$$

If more accuracy is required then the effects of the input bias current (I_{REF}) must be taken into account. The formula below accounts for the error this current produces.

$$V_{KA} = 2.5 * \left(1 + \frac{R1}{R2}\right) + I_{REF} * R1$$

Smaller values of programming resistors tend to minimize bias current errors. In this respect the low input current characteristics of the LX6431B helps to reduce the power dissipation on the programming resistors by a factor of five compared to other references like the TL1431 and TL431.

The LX6431 series of voltage references have an enhanced circuit design that can tolerate any value of cathode to anode capacitance.

PARAMETER MEASUREMENT INFORMATION

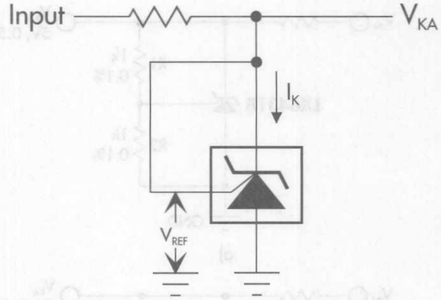


FIGURE 9 — TEST CIRCUIT FOR $V_{KA} = V_{REF}$

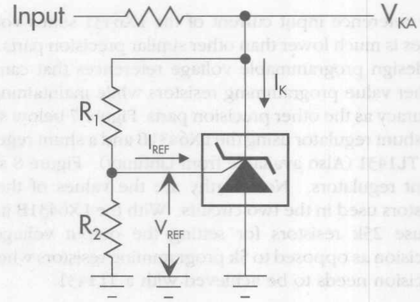


FIGURE 10 — TEST CIRCUIT FOR $V_{KA} > V_{REF}$

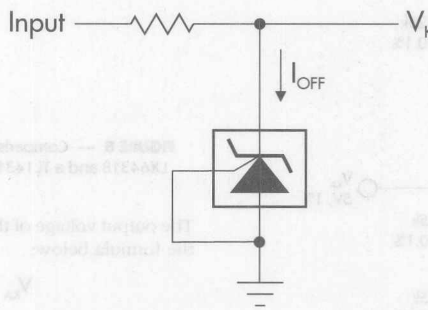


FIGURE 11 — TEST CIRCUIT FOR I_{OFF}

LINFINITY MICROELECTRONICS

TYPICAL CHARACTERISTICS

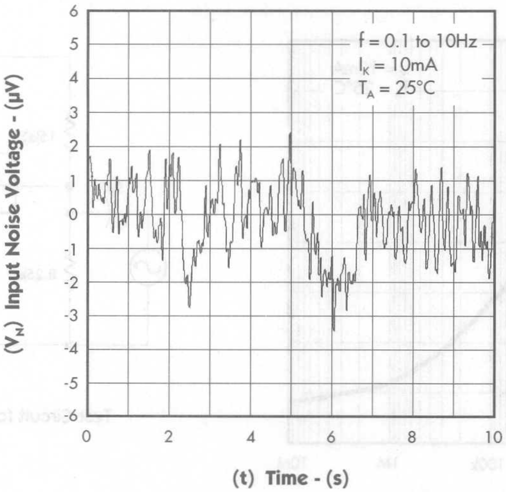
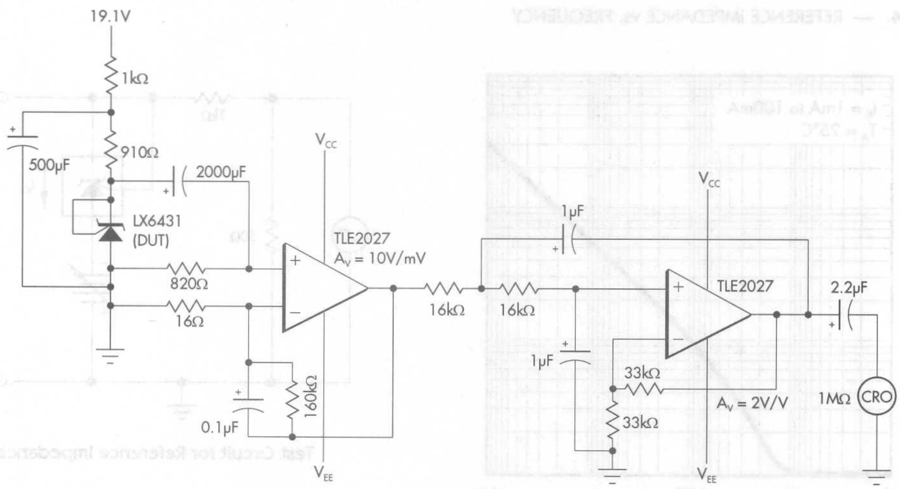


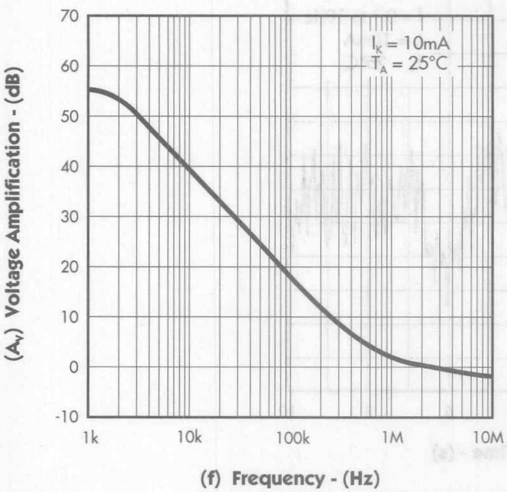
FIGURE 12. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

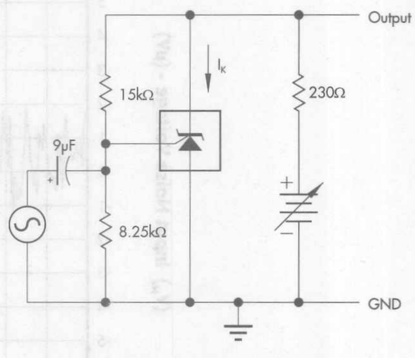


Test Circuit for 0.1Hz to 10Hz Equivalent Input Noise Voltage

TYPICAL CHARACTERISTICS

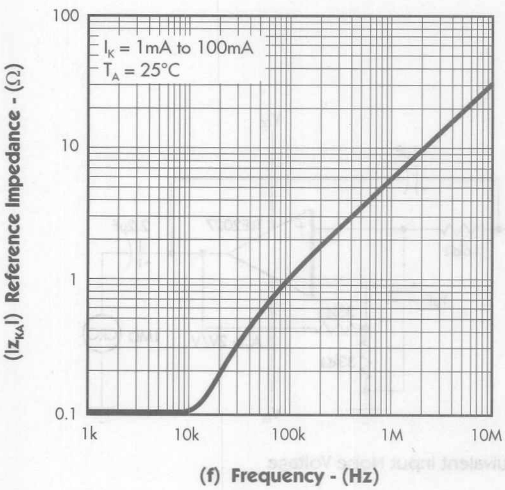
FIGURE 13. — SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

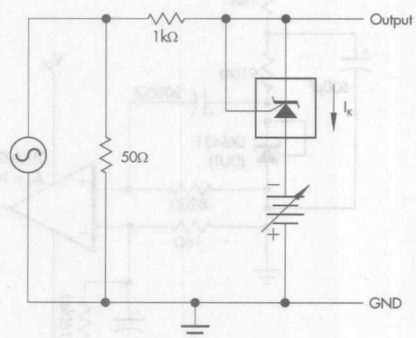




Test Circuit for Voltage Amplification

FIGURE 14. — REFERENCE IMPEDANCE vs. FREQUENCY



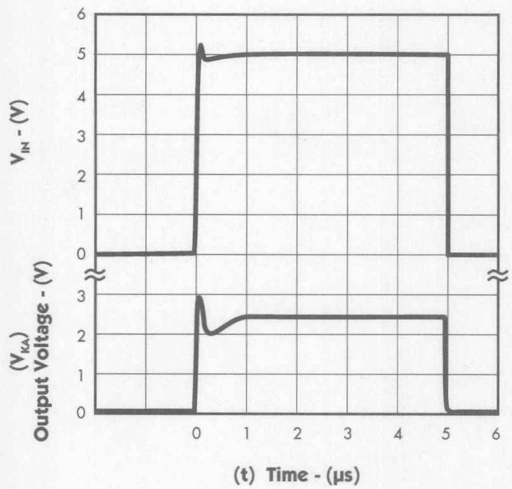


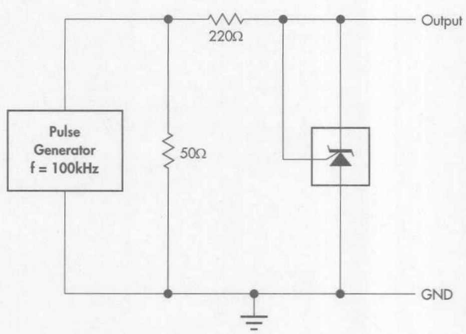
Test Circuit for Reference Impedance

LINFINITY MICROELECTRONICS

TYPICAL CHARACTERISTICS

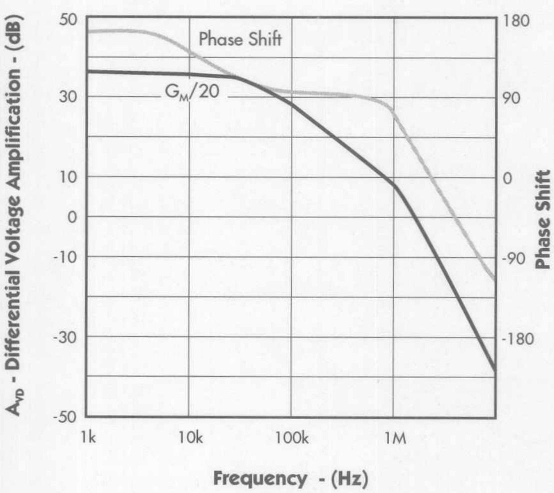
FIGURE 15. — PULSE RESPONSE

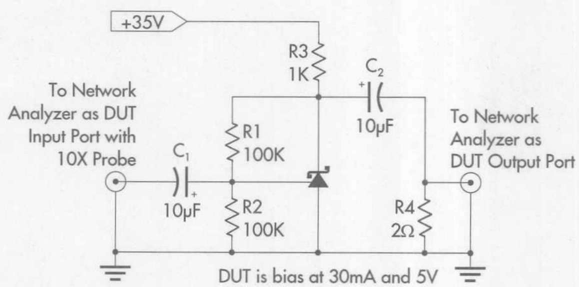




Test Circuit for Pulse Response

FIGURE 16. — DIFFERENTIAL VOLTAGE AMPLIFICATION vs. FREQUENCY





Test Setup for Measuring A_{VD} vs. Frequency

LINFINITY MICROELECTRONICS

Notes

SG103-x.x

VOLTAGE REFERENCES

NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

DESCRIPTION

The SG103 is a two-terminal integrated circuit designed for analog and/or digital applications requiring precision voltage reference. The SG103 is an improved version of the National LM103 voltage reference. The design uses the band-gap voltage of the silicon as an internal reference for a tightly regulated output voltage. The advantages of this method over single junction zener diodes are: lower turn on drift, better temperature coefficient, sharper breakdown characteristics (line regulation) and lower dynamic impedance (load regulation). The I.C. is available in thirteen different voltages ranging from 1.8V to 5.1V (See Table below). The SG103 is packaged in a hermetically sealed, modified TO-46 header and is specified for operation over the full military ambient temperature range of -55°C to +125°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

KEY FEATURES

- STANDARD VOLTAGE TOLERANCE ±10%
- PRECISION BAND GAP DESIGN
- EXCEPTIONALLY SHARP BREAKDOWN
- LOW DYNAMIC IMPEDANCE FROM 10μA TO 10mA (IMPROVED OVER LM103)
- IMPROVED TEMPERATURE COEFFICIENT
- LOW CAPACITANCE
- PERFORMANCE GUARANTEED OVER FULL MILITARY TEMPERATURE RANGE

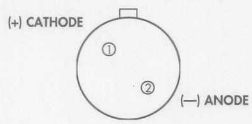
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

AVAILABLE OPTIONS PER PART #

Part #	Reference Voltage
SG103-1.8	1.8V
SG103-2.4	2.4V
SG103-2.7	2.7V
SG103-3.3	3.3V
SG103-4.7	4.7V
SG103-5.1	5.1V

PACKAGE PIN OUTS



Z PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Z TO-46 Metal Can 2-pin
-55 to 125	SG103-x.xZ
DESC	SG103-1.8Z/DESC
	SG103-2.7Z/DESC
	SG103-4.7Z/DESC

"x.x" refers to Reference Voltage, see table above.

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG143

HIGH-VOLTAGE OPERATIONAL AMPLIFIER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG143 is a general-purpose high-voltage operational amplifier featuring operation to ±40V and overvoltage protection up to ±40V. Increased slew rate, together with higher common-mode and supply rejection, insure improved performance at high supply voltages. Operating characteristics are independent of supply voltage and temperature. These devices are intended for use in high voltage applications where common-mode input ranges, high output voltage swings, and low input currents are required. Also, they are internally compensated and are pin compatible with industry standard operational amplifiers.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

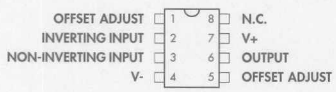
KEY FEATURES

- ±4.0V TO ±40V SUPPLY VOLTAGE RANGE
- ±37V OUTPUT VOLTAGE SWING
- ±24V COMMON-MODE VOLTAGES
- OVERVOLTAGE PROTECTION
- OUTPUT SHORT CIRCUIT PROTECTION

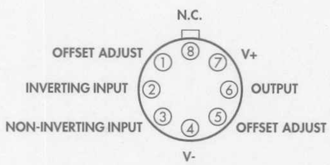
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



T PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	T TO-99 Metal Can 8-pin
-55 to 125	SG143Y	SG143T
MIL-STD-883	SG143Y/883B	SG143T/883B
DESC	SG143Y/DESC	SG143T/DESC

FOR FURTHER INFORMATION CALL (714) 898-8121

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1503/SG2503/SG3503

PRECISION 2.5 VOLT REFERENCE

PRODUCTION DATA SHEET

DESCRIPTION

This monolithic integrated circuit is a fully self-contained precision voltage reference generator, internally trimmed for ±1% accuracy. Requiring less than 2mA in quiescent current, this device can deliver in excess of 10mA with total load- and line-induced tolerances of less than 0.5%. In additon to voltage accuracy, internal trimming achieves a temperature coefficient of output voltage of typically 10 ppm/°C.

As a result, these references are excellent choices for application to critical instrumentation and D-to-A converter systems.

The SG1503 is specified for operation over the full military ambient temperature range of -55°C to 125°C , while the SG2503 is designed for -25°C to 85°C and the SG3503 for commercial applications of 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

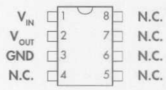
KEY FEATURES

- OUTPUT VOLTAGE TRIMMED TO ±1%
- INPUT VOLTAGE RANGE OF 4.5 TO 40V
- TEMPERATURE COEFFICIENT OF 10ppm/°C
- QUIESCENT CURRENT TYPICALLY 1.5mA
- OUTPUT CURRENT IN EXCESS OF 10mA
- INTERCHANGEABLE WITH MC1503 AND AD580

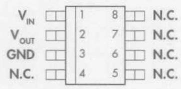
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

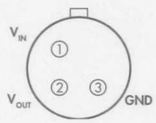
PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)



DM PACKAGE
(Top View)



T PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	DM Plastic SOIC 8-pin	T TO-39 Metal Can 3-pin
0 to 70	SG3503M	SG3503Y	SG3503DM	SG3503T
-25 to 85	SG2503M	SG2503Y	—	SG2503T
-55 to 125	—	SG1503Y	—	SG1503T
MIL-STD-883	—	SG1503Y/883B	—	SG1503T/883B
DESC	—	SG1503Y/DESC	—	SG1503T/DESC

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3503DMT)

FOR FURTHER INFORMATION CALL (714) 898-8121
11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1536/SG1436

HIGH-VOLTAGE OPERATIONAL AMPLIFIER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG1536 series of monolithic amplifiers is designed specifically for use in high voltage applications up to ±40V and where high common-mode input ranges, high output voltage swings, and low input currents are required. These devices are internally compensated and are pin compatible with industry standard operational amplifiers.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

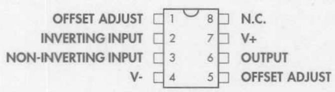
KEY FEATURES

- HIGH SUPPLY VOLTAGE CAPABILITY
- HIGH OUTPUT VOLTAGE SWING
- HIGH COMMON-MODE VOLTAGE RANGE
- INTERNAL FREQUENCY COMPENSATION
- INPUT CURRENT 35nA MAXIMUM OVER TEMPERATURE

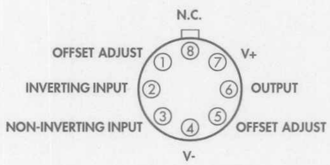
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

PACKAGE PIN OUTS



M & Y PACKAGE
(Top View)



T PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	T TO-99 Metal Can 8-pin
0 to 70	SG1436M	SG1436Y	SG1436T
-55 to 125	—	SG1536Y	SG1536T
MIL-STD-883	—	SG1536Y/883B	SG1536T/883B
DESC	—	SG1536Y/DESC	SG1536T/DESC

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LINFINITY
MICROELECTRONICS

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

TL431/TL431A/TL431B

PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

DESCRIPTION

The TL431/TL431A/TL431B series precision adjustable three terminal shunt voltage regulators are pin-to-pin compatible with the industry standard TL431. The output voltage of this reference is programmable by using two external resistors from 2.5V to 36V.

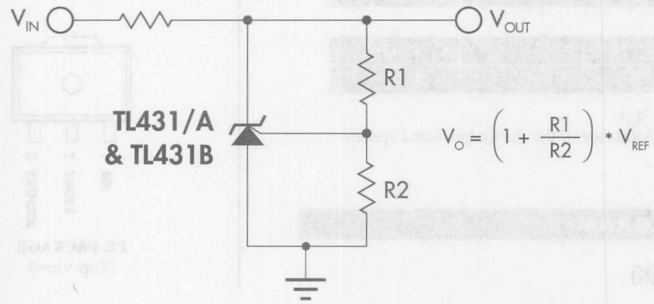
These devices offer low output impedance for improved load regulation. The typical output impedance of these devices is 200mΩ. These devices find application in the feedback path of switching power supplies, OVP crowbar circuits, reference for A/D, D/A, and as zener diodes with improved turn-on characteristics.

KEY FEATURES

- INITIAL VOLTAGE REFERENCE ACCURACY OF 0.4% (TL431B)
- SINK CURRENT CAPABILITY 1mA to 100mA
- TYPICAL OUTPUT DYNAMIC IMPEDANCE LESS THAN 200mΩ; TYPICAL OUTPUT IMPEDANCE OF THE TL431B LESS THAN 100mΩ
- ADJUSTABLE OUTPUT VOLTAGE FROM 2.5V TO 36V
- AVAILABLE IN SURFACE-MOUNT PACKAGES
- LOW OUTPUT NOISE
- TYPICAL EQUIVALENT FULL RANGE TEMPERATURE COEFFICIENT OF 30ppm/°C
- DIRECT PIN-TO-PIN REPLACEMENT FOR INDUSTRY STANDARD TL431 AND TL1431

PRODUCT HIGHLIGHT

PRECISION PROGRAMMABLE REFERENCES



PACKAGE ORDER INFORMATION

T_A (°C)	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	2%	TL431CDM	TL431CLP	TL431CPK
	1%	TL431ACDM	TL431ACLP	TL431ACPK
	0.4%	TL431BCDM	TL431BCLP	TL431BCPK
-40 to 85	2%	TL431IDM	TL431ILP	TL431IPK
	1%	TL431AIDM	TL431AILP	TL431AIPK
	0.4%	TL431BIDM	TL431BILP	TL431BIPK

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. TL431CDMT) TO-92 (LP) package also available in ammo-pack.

TL431/TL431A/TL431B

Precision Programmable References

Production Data Sheet

ABSOLUTE MAXIMUM RATINGS (Note 1)

Cathode to Anode Voltage (V_{KA}) (Note 2) .... -0.3V to 37V
Reference Input Current (I_{REF}) .... -50µA to 10mA
Continuous Cathode Current (I_K) .... -100mA to 150mA
Operating Junction Temperature
Plastic (DM, LP & PK Packages) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.
Note 2. Voltage values are with respect to the anode terminal unless otherwise noted.

THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	165°C/W

LP PACKAGE:

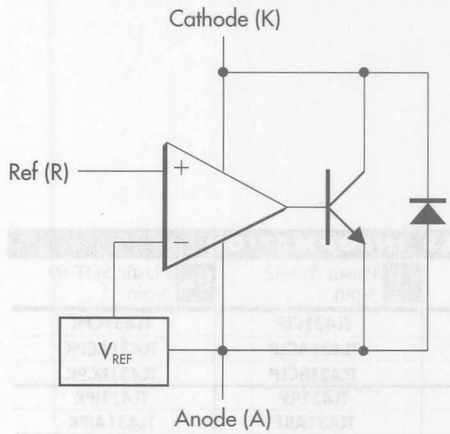
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	156°C/W

PK PACKAGE:

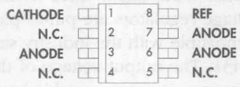
THERMAL RESISTANCE-JUNCTION TO TAB, θ_{JT}	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	71°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

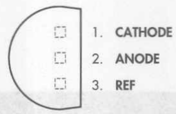
BLOCK DIAGRAM



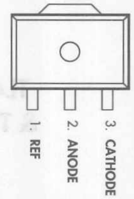
PACKAGE PIN OUTS



DM PACKAGE
(Top View)



LP PACKAGE
(Top View)



PK PACKAGE
(Top View)

LINFINITY MICROELECTRONICS

TL431/TL431A/TL431B

PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for TL431C/TL431AC/TL431BC with $0°C \leq T_A \leq 70°C$, TL431I/TL431AI/TL431BI with $-40°C \leq T_A \leq 85°C$.)

Parameter		Symbol	Test Conditions	TL431/431A/431B			Units
				Min.	Typ.	Max.	
Reference Input Voltage	TL431	V_{REF}	$I_K = 10mA$, $V_{KA} = V_{REF}$, $T_A = 25°C$	2440	2495	2550	mV
	TL431A		$I_K = 10mA$, $V_{KA} = V_{REF}$, $T_A = 25°C$	2470	2495	2520	mV
	TL431B		$I_K = 10mA$, $V_{KA} = V_{REF}$, $T_A = 25°C$	2490	2500	2510	mV
Reference Drift	TL431C		$I_K = 10mA$, $V_{KA} = V_{REF}$		4	17	mV
	TL431I		$I_K = 10mA$, $V_{KA} = V_{REF}$		5	30	mV
	TL431AC	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_K = 10mA$, $V_{KA} = V_{REF}$		4	17	mV
	TL431AI		$I_K = 10mA$, $V_{KA} = V_{REF}$		5	30	mV
	TL431BC		$I_K = 10mA$, $V_{KA} = V_{REF}$		4	15	mV
	TL431BI		$I_K = 10mA$, $V_{KA} = V_{REF}$		5	20	mV
Voltage Ratio, Ref to Cathode	TL431, TL431A		$I_K = 10mA$, $V_{KA} = 2.5V$ to $36V$		-1.4	-2.7	mV/V
(Note 4)	TL431B		$I_K = 10mA$, $V_{KA} = 2.5V$ to $36V$		-1.1	-2	mV/V
Reference Input Current	TL431,TL431A	I_{REF}	$V_{KA} = V_{REF}$, $T_A = 25°C$		2	4	µA
	TL431B		$V_{KA} = V_{REF}$, $T_A = 25°C$		1.5	1.9	µA
			$V_{KA} = V_{REF}$, T_A = Operating Range			2.3	µA
Minimum Operating Current		I_{MIN}	$V_{KA} = V_{REF}$ to $36V$		0.4	1	mA
Off-State Cathode Current	TL431	I_{OFF}	$V_{KA} = V_{REF}$ to $36V$, $T_A = 25°C$		0.1	1	µA
	TL431A		$V_{KA} = V_{REF}$ to $36V$, $T_A = 25°C$		0.1	1	µA
	TL431B		$V_{KA} = V_{REF}$ to $36V$, T_A = Operating Range			2	µA
			$V_{KA} = 36V$, $V_{REF} = 0V$, $T_A = 25°C$		0.18	0.5	µA
Dynamic Impedance	TL431	$\lvert Z_{KA} \rvert$	$V_{KA} = V_{REF}$, $I_K = 1mA$ to $100mA$, $f \leq 1kHz$, $T_A = 25°C$		0.2	0.5	Ω
	TL431B		$V_{KA} = V_{REF}$, $I_K = 1mA$ to $100mA$, $f \leq 1kHz$, $T_A = 25°C$		0.1	0.2	Ω

Note 3. These parameters are guaranteed by design.

Note 4. $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ Ratio of change in reference input voltage to the change in cathode voltage.

LINFINITY MICROELECTRONICS

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Parameter Measurement Information

Typical Characteristics

Application Information

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — REFERENCE VOLTAGE vs. FREE-AIR TEMPERATURE

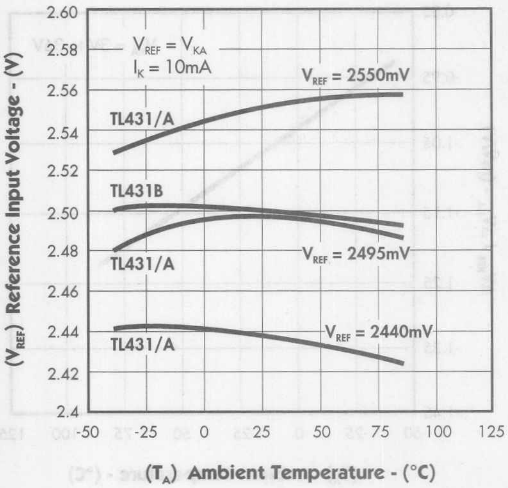


FIGURE 2. — REFERENCE CURRENT vs. FREE-AIR TEMPERATURE

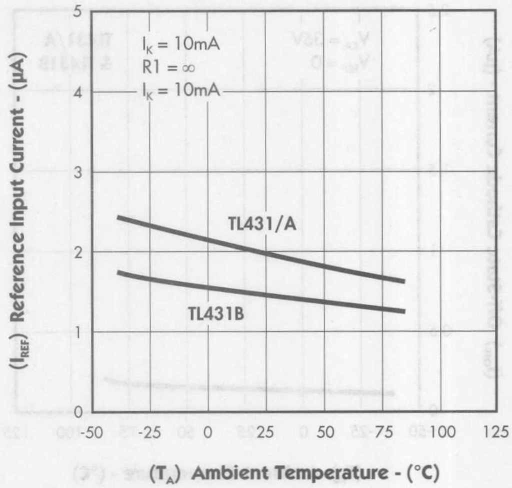


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

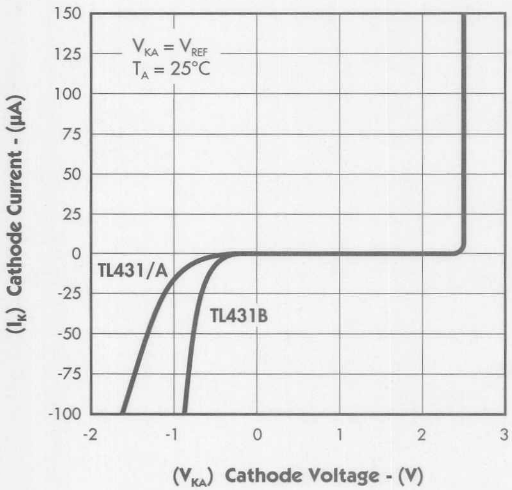
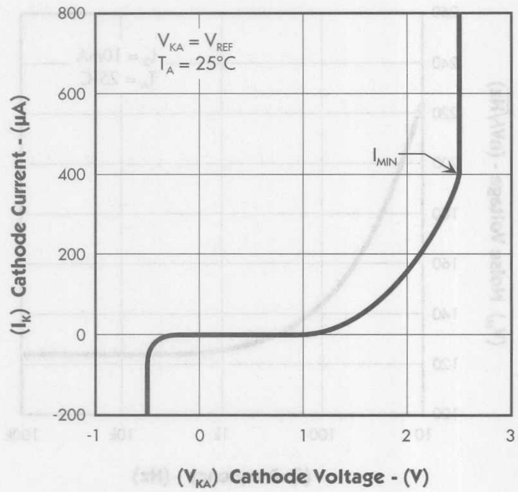


FIGURE 4. — CATHODE CURRENT vs. CATHODE VOLTAGE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE

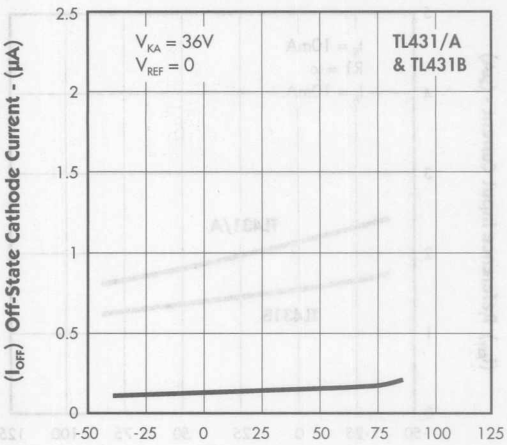


FIGURE 6. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

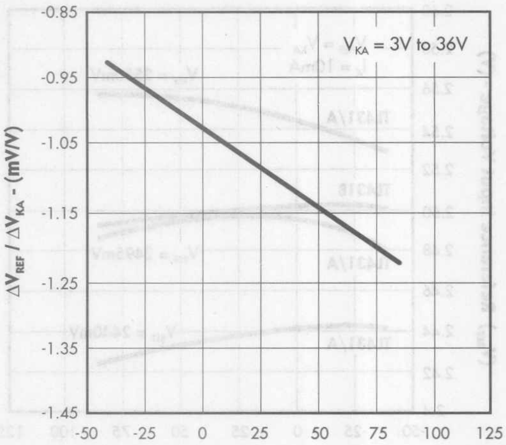
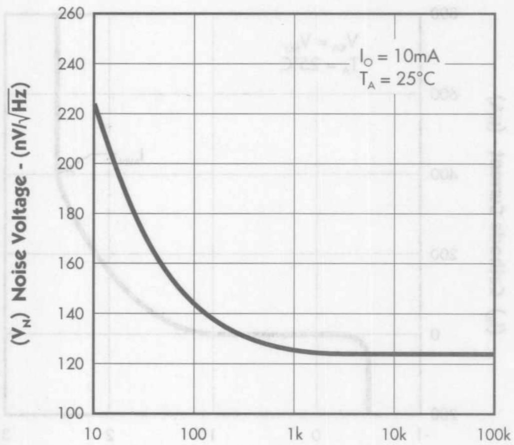


FIGURE 7. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY



LINFINITY MICROELECTRONICS

PARAMETER MEASUREMENT INFORMATION

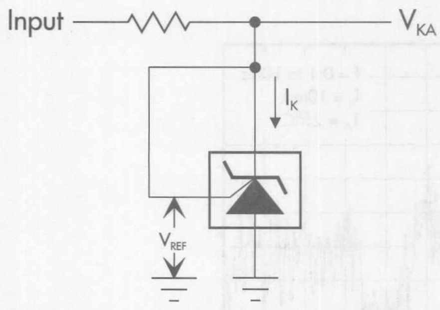


FIGURE 8 — TEST CIRCUIT FOR $V_{KA} = V_{REF}$

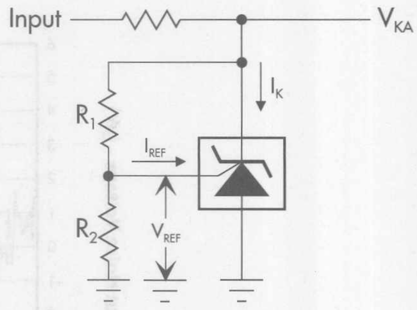


FIGURE 9 — TEST CIRCUIT FOR $V_{KA} > V_{REF}$

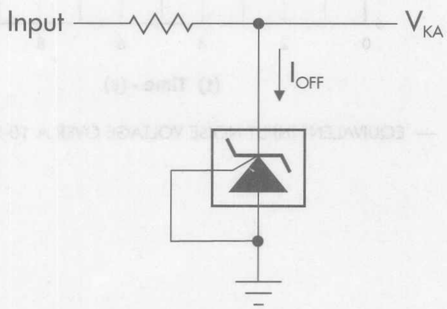


FIGURE 10 — TEST CIRCUIT FOR I_{OFF}

TYPICAL CHARACTERISTICS

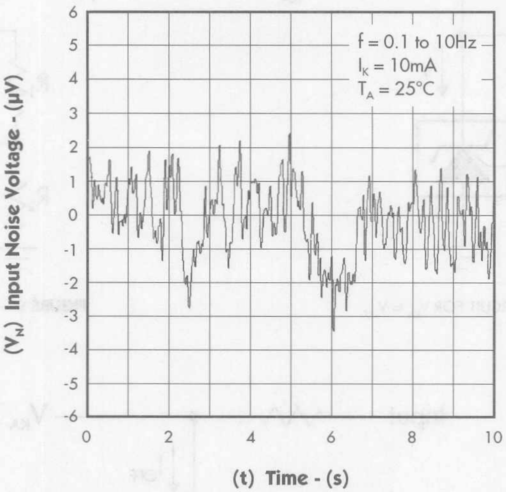
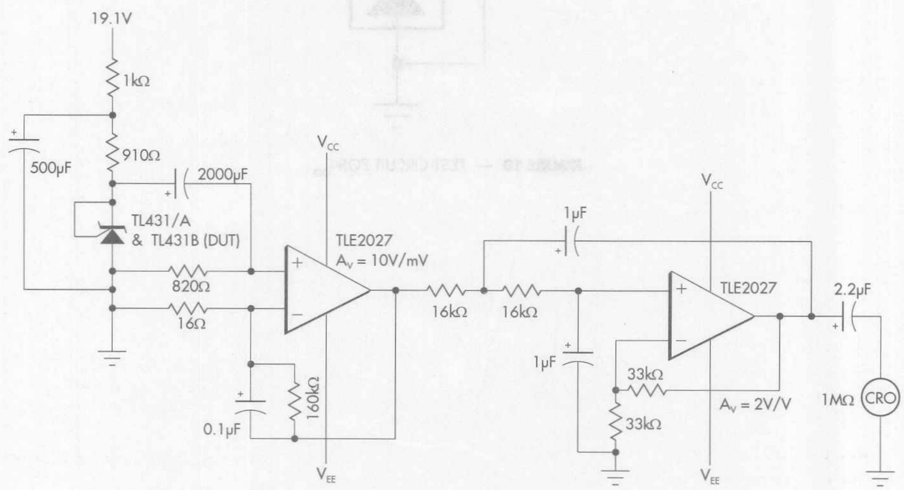


FIGURE 11. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD

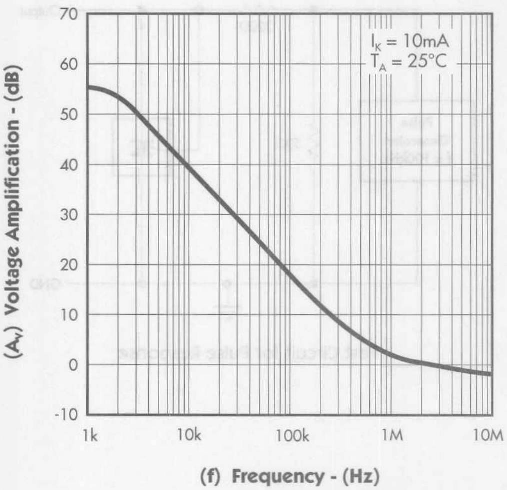


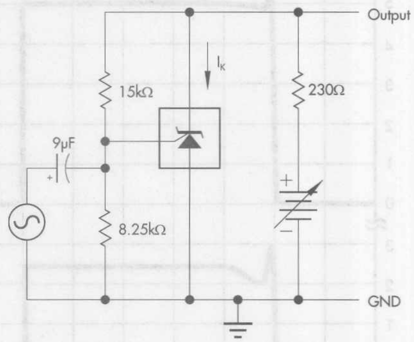
Test Circuit for 0.1Hz to 10Hz Equivalent Input Noise Voltage

LINFINITY MICROELECTRONICS

TYPICAL CHARACTERISTICS

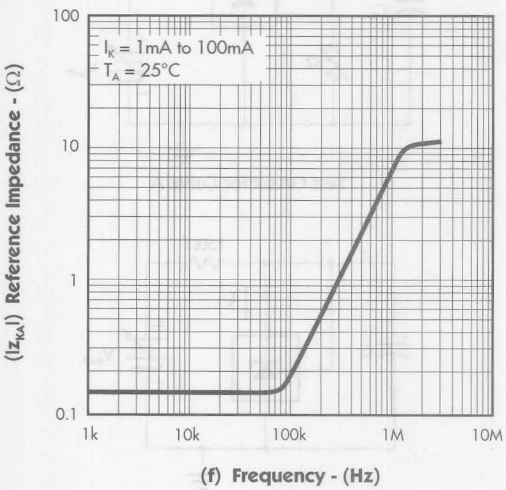
FIGURE 12. — SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

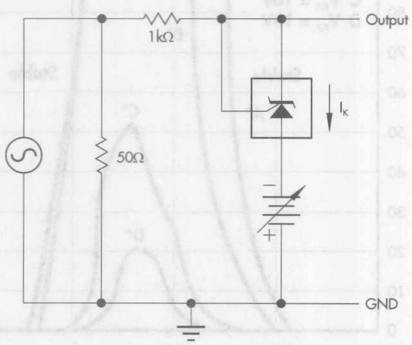




Test Circuit for Voltage Amplification

FIGURE 13. — REFERENCE IMPEDANCE vs. FREQUENCY



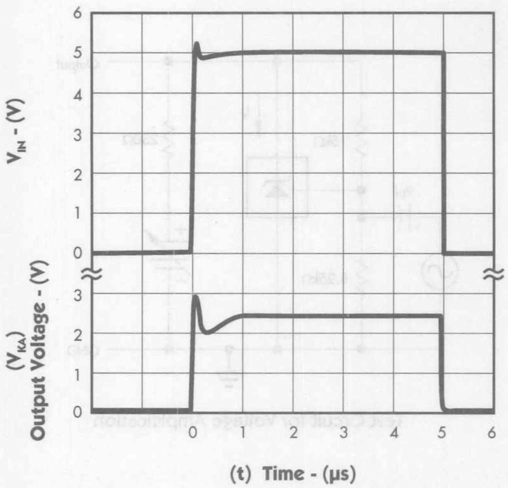


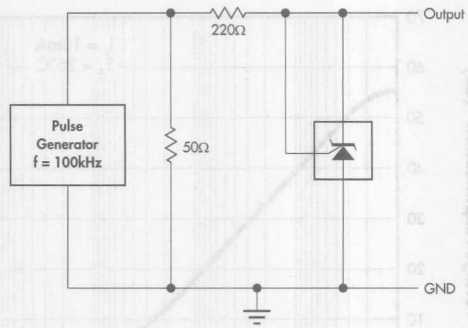
Test Circuit for Reference Impedance

LINFINITY MICROELECTRONICS

TYPICAL CHARACTERISTICS

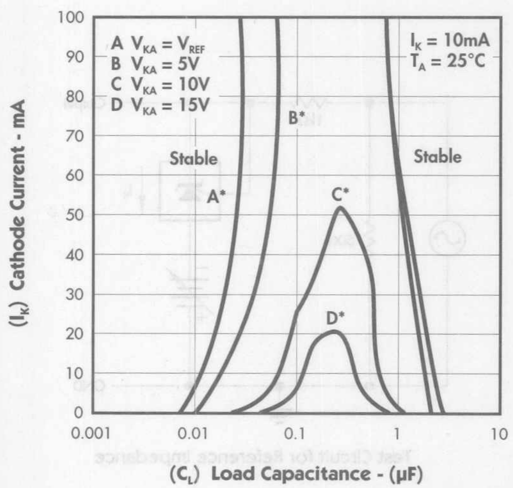
FIGURE 14. — PULSE RESPONSE

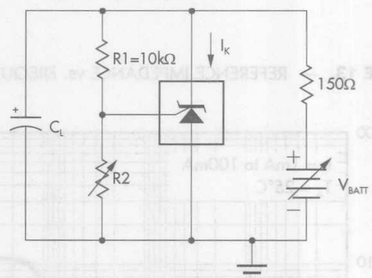




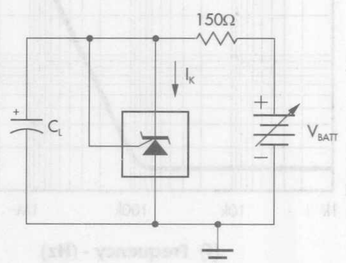
Test Circuit for Pulse Response

FIGURE 15. — STABILITY BOUNDARY CONDITIONS





Test Circuit for Curve A

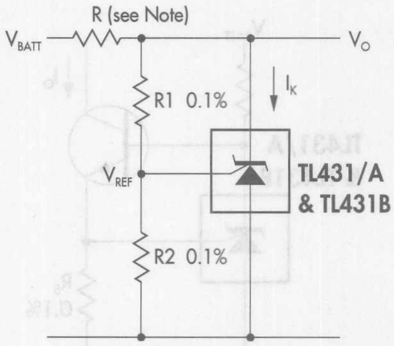


Test Circuit for Curves B, C, and D

* The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial V_{KA} and I_K conditions with C_L = 0. V_{BATT} and C_L were then adjusted to determine the ranges of stability.

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION



$$V_O = \left(1 + \frac{R1}{R2}\right) * V_{REF}$$

Note: R should provide ≥ 1mA cathode current to the TL431/A & TL1431 at minimum V_{BATT}.

FIGURE 16 — SHUNT REGULATOR

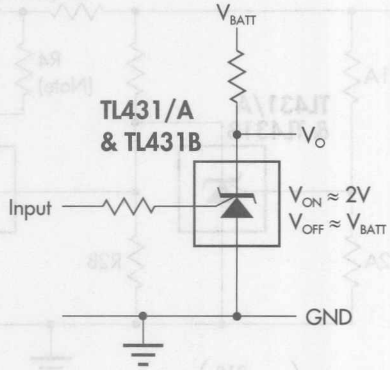
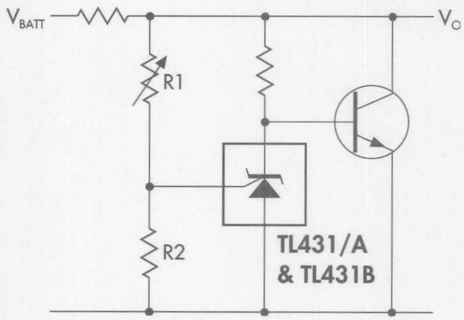
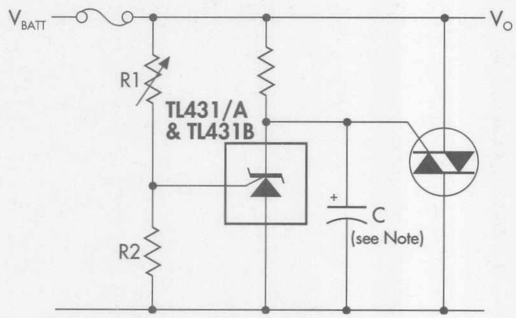


FIGURE 17 — SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD



$$V_O = \left(1 + \frac{R1}{R2}\right) * V_{REF}$$

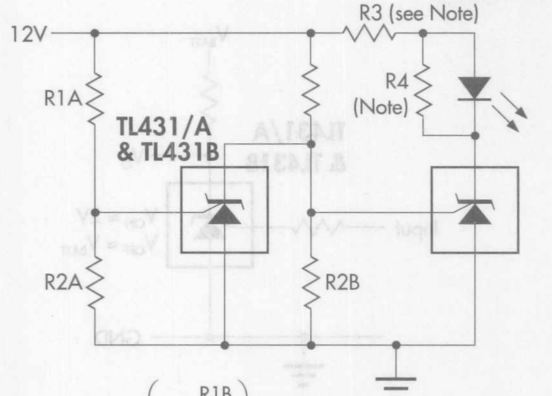
FIGURE 18 — HIGH CURRENT SHUNT REGULATOR



Note: Refer to the stability boundary conditions in Figure 15 to determine allowable values for C.

FIGURE 19 — CROWBAR CIRCUIT

APPLICATION INFORMATION



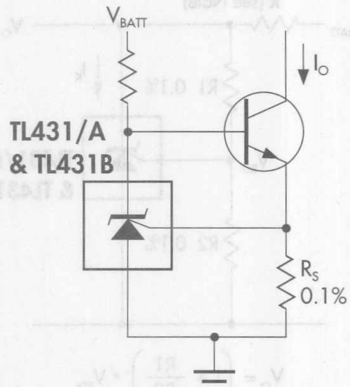
$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right) * V_{REF}$$

$$\text{High Limit} = \left(1 + \frac{R1B}{R2B}\right) * V_{REF}$$

LED On when
Low Limit < V_{BATT} < High Limit

Note: R3 and R4 are selected to provide the desired LED intensity and ≥ 1mA cathode current to the TL431/A & TL431B at the available V+.

FIGURE 20 — VOLTAGE MONITOR



$$I_O = \left(\frac{V_{REF}}{R_S}\right)$$

FIGURE 21 — PRECISION CONTANT-CURRENT SINK

Thumb Index

LINFINITY
MICROELECTRONICS

Notes

LINFINITY
MICROELECTRONICS

Section Index

MOTION CONTROL CIRCUITS

Disk Drive Products

Power Drivers

PWM Controllers

Power Operational Amplifiers

Bold = New Product, ****Bold Italic*** = Preliminary

LINFINITY MICROELECTRONICS

Selection Guide

Motion Control Circuits

Disk Drive Products

Device Type: LX3187

Description: SERVO ACTUATED DRIVE SUBSYSTEM.

Page # ?

Key Features:
1. Output current of up to 3A for 12V applications.
2. No supply isolation device required.
3. Excellent transient response without crossover distortion.
4. 11-bit digital analog conversion without gain switching.
5. Voltage reference with 2% tolerance.
6. 5V, 12V built in power monitor.
7. Low supply current in disable mode.
8. Very small 7x7 surface mount QFP package.

Packages: TF

Device Type: LX3191B

Description: HALL-LESS SPINDLE MOTOR DRIVER.

Page # ?

Key Features:
1. Serial data control interface.
2. External power drive.
3. Bipolar PWM start reduces start up power dissipation of low side FETs.
4. Trapezoidal current shape control reduces motor acoustic noise eliminates snubber.
5. Power good, brake delay, external frequency PWM off-time control.
6. Evaluation board available.

Packages: Q, TF

Power Drivers

Device Type: SG1635/3635

Description: HALF-BRIDGE DRIVER.

Page # ?

Key Features:
1. Source or sink 5A peak.
2. Half-bridge with internal diodes.
3. TTL input compatiblility.
4. Either dual- or tri-state output.
5. Direct PWM motor drive from microprocessor.
6. Built-in thermal protection.

Characteristics:

$I_{O(PK)}$	5A
$I_{O(CONT)}$	3A
$V_{C(MAX)}$	35V
$V_{CC(MAX)}$	35V

Packages: R, P

Device Type: SG3645

Description: QUAD POWER DRIVER.

Page # ?

Key Features:
1. Four open collector outputs.
2. Internal clamp diodes.
3. Thermal shutdown protection.
4. TTL input compatibility.
5. Common enable pin.

Characteristics:

$I_{O(PK)}$	3.5A
$I_{O(CONT)}$	2.5A
$V_{C(MAX)}$	60V
$V_{CC(MAX)}$	40V

Packages: W

MOTION CONTROL CIRCUITS

PWM Controllers

Device Type	Description	Key Features	Characteristics	Packages
SG1731/2731/3731	DC MOTOR PULSE-WIDTH MODULATOR. Page # ?	1. Dual uncommitted totem pole outputs. 2. Maximum frequency to 350KHz. 3. Adjustable deadband operation. 4. High slew rate op-amp. 5. Digital SHUTDOWN input.	$I_{O(PK)}$ 400mA $I_{O(CONT)}$ 200mA $V_{C(MAX)}$ ±25V (50V) $V_{CC(MAX)}$ ±25V (36V)	J N

Power Operational Amplifiers

Device Type	Description	Key Features	Characteristics	Packages
SG3272	DUAL POWER AMPLIFIER. Page # ?	1. Two operational amplifiers. 2. Internal flyback protection diodes. 3. Common mode range includes ground. (V_{EE}) 4. Ideal for driving motors in "H" bridge configurations. 5. Internally compensated. 6. Thermal shutdown protection.	$I_{O(PK)}$ 1.5A $I_{O(CONT)}$ 1A $V_{C(MAX)}$ 18V $I_{S(MAX)}$ 15mA	M DWP
SG2273/3273	SINGLE POWER AMPLIFIER. Page # ?	1. Full output swing at ±1A. 2. High inductive load drive capability. 3. Internal flyback protection diodes. 4. Common-mode range includes ground. 5. Low input offset voltage. 6. Large diff. input voltage range. 7. Thermal shutdown protection.	$I_{O(PK)}$ 1.5A $I_{O(CONT)}$ 1A $V_{C(MAX)}$ 18V $V_{CC(MAX)}$ 15mA	P

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX3187

SERVO ACTUATOR DRIVE SUBSYSTEM

PRELIMINARY DATA SHEET

DESCRIPTION

The LX3187 is a transconductor power driver for the voice coil actuator in high-performance disk drive applications. It provides the additional functions of precision reference voltage, 11-bit digital to analog conversion, power monitor / power-on reset generation, independent current sense amplifier, uncommitted buffer amplifier, and velocity limiting power off park circuit. The only active components external to the 7 x 7 mm QFP package are 4 low-cost, surface-mount bipolar transistors and silicon recirculation diodes suitable for the desired load current of up to 3A.

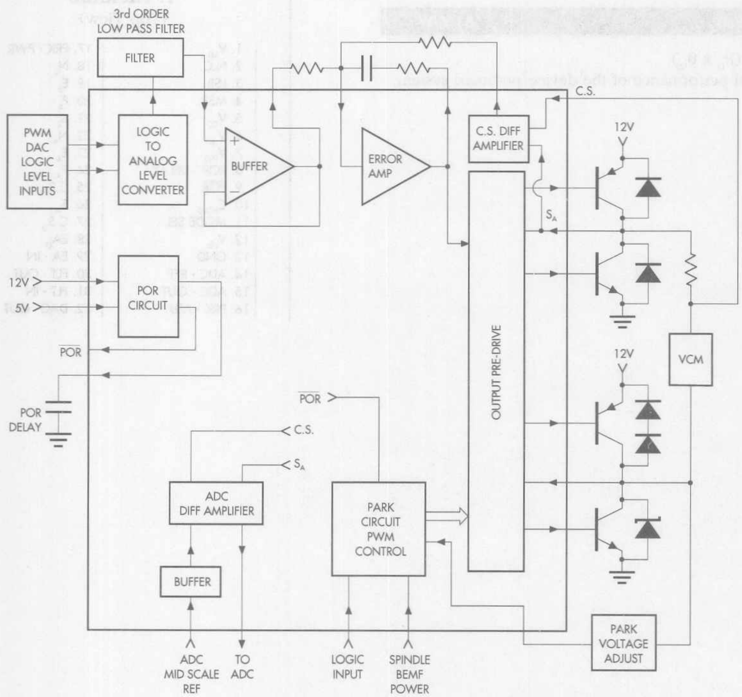
KEY FEATURES

- OUTPUT CURRENTS OF UP TO 3A FOR 12V APPLICATIONS
- NO SUPPLY ISOLATION DEVICE REQUIRED, NEAR RAIL-TO-RAIL OUTPUT VOLTAGE
- EXCELLENT TRANSIENT RESPONSE WITHOUT CROSSOVER DISTORTION
- 11-BIT DIGITAL TO ANALOG CONVERSION WITHOUT GAIN SWITCHING
- VOLTAGE REFERENCE WITH 2% TOLERANCE
- 5V, 12V BUILT-IN POWER MONITOR / POWER-ON RESET GENERATION
- ADDITIONAL CURRENT SENSE AMPLIFIER WITH INDEPENDENT OUTPUT VOLTAGE REFERENCE AND BUFFERED INPUT
- SWITCHING MODE PARK CIRCUIT THAT OPERATES TO LESS THAN 2 V/BEMF AND PROVIDES ADJUSTABLE VELOCITY LIMITING
- LOW SUPPLY CURRENT IN DISABLE MODE
- VERY SMALL 7 X 7 SURFACE-MOUNT QFP PACKAGE
- UNCOMMITTED BUFFER AMPLIFIER TO BE CONFIGURED AS 3RD ORDER LOW PASS FILTER

APPLICATIONS

- HIGH-CAPACITY, HIGH-PERFORMANCE VOICE COIL SERVO SYSTEMS
- EVALUATION BOARD AVAILABLE

PRODUCT HIGHLIGHT



PACKAGE ORDER INFO

T_A (°C)	TF 32-Pin TQFP
0 to 70	LX3187CTF

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX3187CTFT)

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

SERVO ACTUATOR DRIVE SUBSYSTEM

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage 15V
Operating Junction Temperature
  Plastic (TF Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

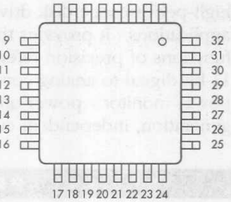
THERMAL DATA

TF PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	81°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system.
All of the above assume no ambient airflow

PACKAGE PIN OUTS



TF PACKAGE
(Top View)

1. V_{REF}	17. PRK - PWR
2. N.C.	18. N_B
3. LSB	19. E_B
4. MSB	20. P_B
5. V_{CC}	21. S_B
6. V_{TH1}	22. N_A
7. V_{TH2}	23. E_A
8. POR - DELAY	24. P_A
9. $\overline{POR}$	25. $C.S_{IN}$
10. C_{HOLD}	26. S_A
11. MODE SEL	27. $C.S_O$
12. V_{DD}	28. EA_O
13. GND	29. EA - IN
14. ADC - REF	30. FLT - OUT
15. ADC - OUT	31. FLT - IN
16. PRK - ADJ	32. DAC - OUT

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over V_{CC} supply voltage of 10.8V to 13.2V, V_{DD} supply voltage of 4.75V to 5.25V and ambient temperature of 0° to 70°C. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature).

Parameter	Symbol	Test Conditions	LX3187 Min.	LX3187 Typ.	LX3187 Max.	Units
Power Consumption						
V_{CC} Supply Current	I_{VCC}	Mode = HIGH, I_{MOTOR} = 0		15	25	mA
Output Stage Bias Current	I_{BO}	Mode = HIGH, I_{MOTOR} = 0				mA
Bias Current Temp Coefficient						%
V_{DD} Supply Current	I_{VDD}	Mode = HIGH, I_{MOTOR} = 0		3		mA
Output Disable Mode Current (12 & 5V)	I_{VCC}	Mode = TRISTATE		TBD		mA
Park Quiecent Current	$I_{PARK\ PWR}$	Mode = LOW, I_{MOTOR} = 0		7.5		mA
Output Drive Section						
NPN Drive Current		R_E, R_C not connected, $P_X = (V_{CC} - 1V)$, $N_X = 1V$, $V_{CC} = 10.8V$	40	50		mA
PNP Drive Current		R_E, R_C not connected, $P_X = (V_{CC} - 1V)$, $N_X = 1V$	40	55		mA
Voltage Gain		S_A / E_{AO} or S_B / E_{AO}	9.8	10	10.2	V/V
Error Amplifier						
Input Bias Current				10	100	nA
Output Source Current		V_O = 6V	2			mA
Output Sink Current		V_O = 2V	2			mA
Output Hi Level		R_L = 10k to V_{REF}	6			V
Output Lo Level		R_L = 10k to V_{REF}			2	V
Input Offset Voltage		$V_{E.A.}$ = 4V	-4		4	mV
Open Loop Gain		R_L = 10k	60	80		dB
Filter Buffer						
Input Bias Current				20	100	nA
Input Offset Voltage		R_L = 2k to 4V	-4		4	mV
Output Source Current		V_O = 6V	2			mA
Output Sink Current		V_O = 2V	2			mA
Output Hi Level		I_O = 2mA	6			V
Output Lo Level		I_O = 2mA			2	V
Slew Rate				0.8		V/µS
Gain				1		V/V
Power Monitor						
12V Threshold Voltage - V_{CC}	V_{TH1}	Supply Ramp Down	10.10	10.35	10.60	V
12V Hysterises - V_{CC}		Ramp Up Hysterises	100	120	140	mV
5V Threshold - V_{DD}	V_{TH2}	Supply Ramp Down	4.475	4.575	4.675	V
5V Hysterises - V_{DD}		Ramp Up Hysterises	45	60	75	mV
Input Resistance (V_{TH1} or V_{TH2})		V_{TH1}		10K		Ω
		V_{TH2}		10K		Ω
POR Delay (pin 8)		C = 0.47µf	50	100	150	ms/µF
POR Output Saturation Voltage		I_O = 500µA			0.8	V
POR Discharge Current			2			mA
POR Leakage Current					10	µA

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Symbol	Test Conditions	LX3187 Min.	LX3187 Typ.	LX3187 Max.	Units
Voltage Reference						
Initial Output Voltage		I_{LOAD}=0mA, T_J=25°C, V_{CC} = 12V, V_{DD} = 5V	3.88	4	4.12	V
Line Regulation		$4.75 < V_{DD} < 5.25V$, $10.8V < V_{CC} < 13.2V$		16	10	mV
Load Regulation		0 to 3mA Load Change, V_{CC} = 12V, V_{DD} = 5V			20	mV
Temp Stability (note 2)				20		mV
Total Voltage Variation (note 2)		Line, Load, Temp	3.80		4.2	V
Output Load Capacitance			0		1000	pF
Current Sense / ADC Amplifier						
Current Sense Voltage Gain		V_{CM} = 6V	3.92	4	4.08	V/V
ADC Voltage Gain		V_{CM} = 6V	2.9	3	3.1	V/V
Gain Change		V_{CM} = -0.8 to V_{CC} + 0.8V	-40			dB
Input Bias Current (ADC REF only)				20	100	nA
Output Offset Voltage (C.S Amp)		$V_{CS} = V_{SA} = V_{CC}/2$	-16	5	16	mV
Output Offset Voltage (ADC Amp)		$V_{ADC\ REF} = V_{REF}$, $V_{CS} = V_{SA} = V_{CC}/2$	-12	3	12	mV
Output Hi Level (C.S Amp)		R_L = 10K to V_{REF}	V_{CC}- 3			V
Output Lo Level (C.S Amp)		R_L = 10K to V_{REF}			2	V
Offset Voltage Change		V_{CM} = -0.8 to V_{CC} + 0.8V	-20		20	mV
Output Source Current (ADC Amp)		ADC - REF = 2.5V, ADC - OUT = 4V	2			mA
Output Sink Current (ADC Amp)		ADC - REF = 2.5V, ADC - OUT = 1V	1			mA
Output Hi Level (ADC Amp)		R_L = 5k to GND	V_{DD}-0.75			V
Output Lo Level (ADC Amp)		R_L = 5k to V_{REF}			1	V
Slew Rate, C.S. Amplifier		C_L = 0, 10k to 2.5V		2.4		V/µsec
Slew Rate, ADC Amplifier		C_L = 50pF, 10k to 2.5V		2.4		V/µsec
Park Circuit						
Reference Voltage		T_A = 25°C, $I_{PRK\ ADJ}$ = 10µA	0.62	0.69	0.76	V
Reference Temp Coefficient				-2		mV/C
P_A & P_B Hold Off Current						mA
Park Adjust Input Current				1		µA
C_{HOLD} Current		$4V < V_{HOLD} < 10V$			4	µA
Output Drive Rds-on		V_{GS} = 4V, I_M= 100mA			30	Ω
Drive Switching Frequency		L_M= 1.25mH, R_M = 5Ω, V_{PRK} = 1V, $V_{PRK\text{-}PWR}$ = 10V		TBD		kHz
N_A Source Drive Current		MODE-SEL = LO, I_M = 100mA, V_{HOLD} = 4V, $V_{PRK\ PWR}$ = 4V	5			mA
N_B Sink Hold Current		MODE-SEL = LO, I_M = 100mA	5			mA
Park/Normal/Disable Mode Select						
Normal Voltage Threshold			0.65 V_{DD}	0.75 V_{DD}		V
Disable Voltage Threshold			0.4_{VDD}	0.5_{VDD}	0.6_{VDD}	V
Park Voltage Threshold				0.25 V_{DD}	0.35 V_{DD}	V
Input Current					±250	µA

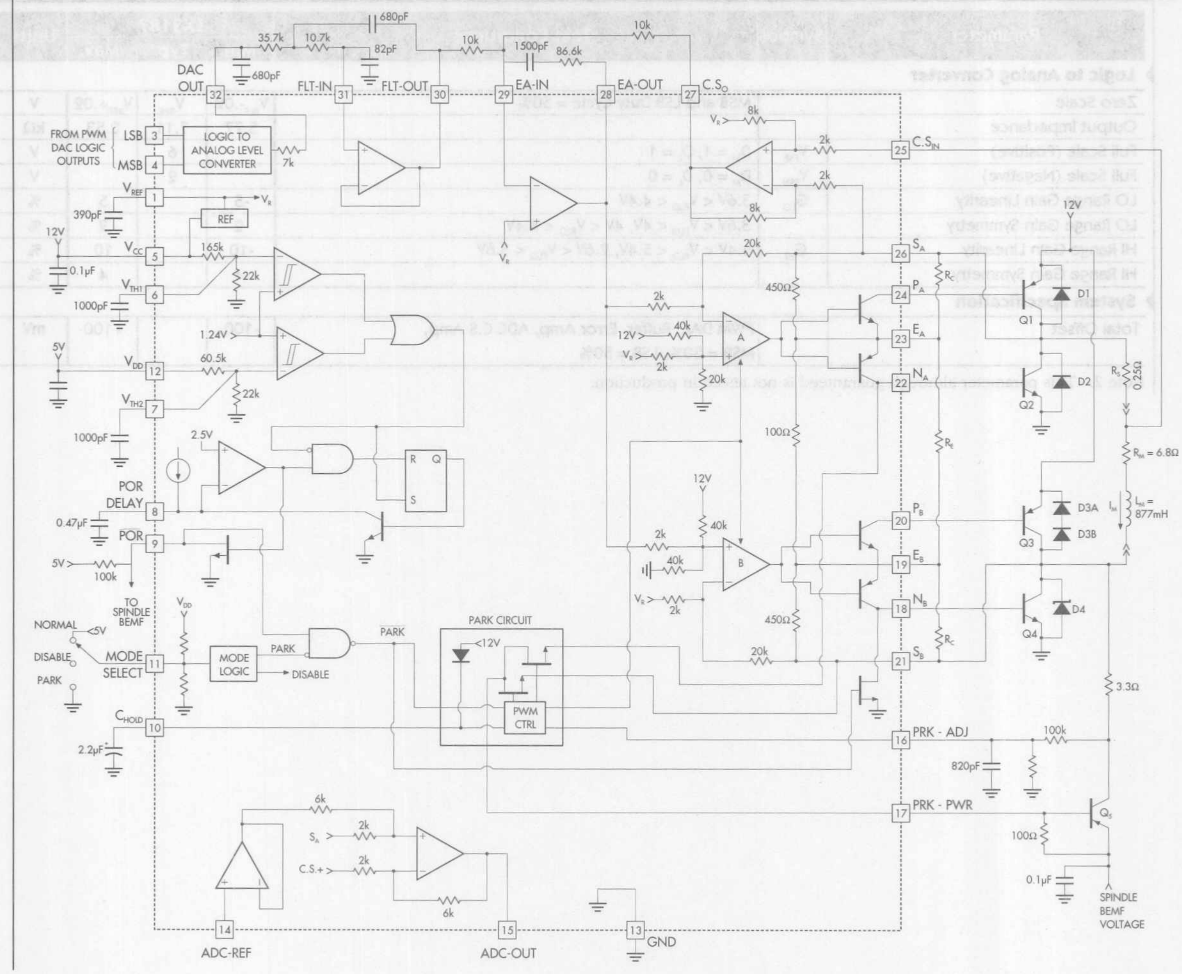
LINFINITY MICROELECTRONICS

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Symbol	Test Conditions	LX3187 Min.	LX3187 Typ.	LX3187 Max.	Units
Logic to Analog Converter						
Zero Scale		MSB and LSB Duty Cycle = 50%	V_{REF}-.02	V_{REF}	V_{REF}+.02	V
Output Impedance			5.77	7.11	8.53	kΩ
Full Scale (Positive)	V_{FSP}	$D_M = 1, D_L = 1$		6		V
Full Scale (Negative)	V_{FSN}	$D_M = 0, D_L = 0$		2		V
LO Range Gain Linearity	G_{LO}	$3.6V < V_{FLO} < 4.4V$	-5		5	%
LO Range Gain Symmetry		$3.6V < V_{FLO} < 4V$, $4V < V_{FLO} < 4.4V$	-2		2	%
HI Range Gain Linearity	G_{HI}	$4.4V < V_{FLO} < 5.4V$, $2.6V < V_{FLO} < 3.6V$	-10		10	%
HI Range Gain Symmetry			-4		4	%
System Specification						
Total Offset		PWM DAC, Buffer, Error Amp, ADC C.S Amp, MSB = 50%, LSB = 50%	-100		+100	mV

Note 2. This parameter although guaranteed is not tested in production.

BLOCK DIAGRAM



LINFINITY MICROELECTRONICS

PIN DESCRIPTION

Pin	#	Description
V_{REF}	1	Reference voltage output. A 390pF capacitor connected from this pin to GND results in maximum stability. Reference output has no short circuit protection and must not exceed it's maximum current rating.
NC	2	No connect.
LSB	3	Lesser significant input data to PWM D to A converter; LSB has 1/32 the weight of MSB on DAC OUT.
MSB	4	More significant input data to PWM D to A converter.
V_{CC}	5	12V supply voltage. A high freq by pass capacitor is normally connected between this pin and GND.
V_{TH1}	6	12V por threshold voltage. An internal resistor divider from V_{CC} to GND sets the 12V por threshold at 10.35V typ. An external resistor divider can be used to change this threshold. A small ceramic capacitor connected from this pin to GND helps to reduce high freq noise.
V_{TH2}	7	5V por threshold voltage. An internal resistor divider from V_{CC} to GND sets the 12V por threshold at 4.6V typ. An external resistor divider can be used to change this threshold. A small ceramic capacitor connected from this pin to GND helps to reduce high freq noise.
POR - DELAY	8	A capacitor from this pin to ground programs por delay time when both supplies are above por threshold plus hysterises, delay circuit is activated and "POR OUTPUT" pin switches high after the delay time. The relationship between delay time and delay capacitor is: $T_D = C_D * 100{,}000$ Sec. (typ).
$\overline{POR}$	9	A logic level output that switches to low position when either supplies are below their threshold points. When both supplies are above POR thresholds plus hysterises voltage, this pin switches from LO to HI after the programmed delay time. Park mode is automatically activated when this pin is switched LO.
C_{HOLD}	10	This pin is normally pulled HI through an internal diode to V_{CC}. Connecting a capacitor from this pin to ground provides sufficient voltage for park logic circuit when V_{CC} is inactive.
MODE SELECT	11	A tri-state logic input that selects mode of operation. Normal Mode = HI Sleep Mode = OPEN Park Mode = LO
V_{DD}	12	5V supply voltage. A high freq by pass capacitor is normally connected between this pin and GND.
GND	13	Ground pin of the IC. This pin is connected to substrate.
ADC - REF	14	This pin is normally connected to mid scale point of ADC reference. Input bias current of this pin is typically 100nA.
ADC - OUT	15	The output pin of the differential amplifier. This pin is normally fed back to ADC. The relationship between this pin and "ADC REF" pin is given by: ADC OUT = $\pm 3 * I_M * R_S$ + ADC - REF.
PRK - ADJ	16	A resistor divider from S_B to GND connected to this pin programs park voltage.
PRK - PWR	17	Spindle motor back EMF provides supply voltage to park circuit power driver via this pin.

LINFINITY MICROELECTRONICS

PIN DESCRIPTION (continued)

Pin	#	Description
N_B	18	This pin is connected to the base of external NPN transistor.
E_B	19	Emitter of B amplifier
P_B	20	This pin is connected to the base of external PNP transistor.
S_B	21	This pin is connected to the other side of the voice coil and the junction of the 2nd pair of external transistors. Internally this pin acts as the inverting path for "B" amplifier.
N_A	22	This pin is connected to the base of external NPN transistor.
E_A	23	Emitter of A amplifier. Connecting resistor R_E and R_C such that $R_C = 4.5 \text{ X } R_E$ as shown on block diagram, increases the current to output transistor bases.
P_A	24	This pin is connected to the base of external PNP transistor.
$C.S_{IN}$	25	This pin acts as positive sense input of the voltage across the current sense resistor during normal mode of operation.
S_A	26	This pin is connected to the junction of the external sense resistor and the voice coil. This pin is internally connected to the inverting side of C.S. differential amplifier and feedback for "A" amplifier.
$C.S_O$	27	Output of the current sense amplifier. This pin provides motor current feedback to the error amplifier relationship between output voltage and motor current is given by: $V_{C.S.\,OUT} = \pm 4 \bullet I_M \bullet R_S + V_{REF}$ where: I_M = MOTOR CURRENT ; R_S = CURRENT SENSE RESISTOR
$E.A_O$	28	Error amplifier output pin. An external compensation network is placed between this pin and the "E.A. IN" pin based on the voice coil parameters. This sets the closed loop transconductance bandwidth of the amplifier.
EA - IN	29	Inverting input of the error amplifier. This pin acts as the summing node for the "C.S. OUTPUT VOLTAGE" and filtered command voltage "FILTER OUT."
FLT - OUT	30	Output pin for buffer amplifier. This pin acts the the filtered output of "DAC OUTPUT VOLTAGE." The amplifier is typically configured as a third order Butterworth low pass filter.
FLT - IN	31	Input pin for buffer amplifier.
DAC - OUT	32	PWM DAC output pin. The output impedance of this pin (typ 7.11K) and a capacitor from this pin to GND creates real pole of the 3rd order low pass filter.

APPLICATION INFORMATION

DIGITAL TO ANALOG CONVERSION

The LX3187 includes a logic to analog conversion circuit with the ability to trim the zero scale command voltage for an overall system offset voltage of less than 5% of the total full scale current. The simplified schematic of this section is shown in Figure 1. The MSB and LSB logic output words are connected to the LX3187 "MSB and "LSB" pins. The bottom current sources are on only during the off time of the inputs, causing the average voltage at the capacitor connected to the "DAC OUT" pin to change as the duty cycle of the logic inputs change. The 12-bit output word should be encoded into MSB and LSB logic signals whose duty cycle is given by:

$$\text{Duty Cycle (MSB)} \equiv D_M = \frac{M_6}{64};$$

$$\text{Duty Cycle (LSB)} \equiv D_L = \frac{32 + L_5}{128}$$

where: 12 bit word = M_6L_5

The average DAC OUTPUT which is given by the output of the 3rd order low pass filter, is given by:

$$V_{FLO} - V_{REF} = V_{FS}\left[2\left(\frac{32}{33}D_M + \frac{1}{33}D_L\right) - 1\right]$$

where: V_{FS} = full scale voltage (2V typ)
V_{REF} = reference voltage (4V typ)
V_{FLO} = filter output (pin 30)

Assuming V_{REF} = 4v results in full scale values of:

V_{FLO} = 6V	for	$D_M = D_L = 1$
V_{FLO} = 4V	for	$D_M = D_L = 1/2$
V_{FLO} = 2V	for	$D_M = D_L = 0$

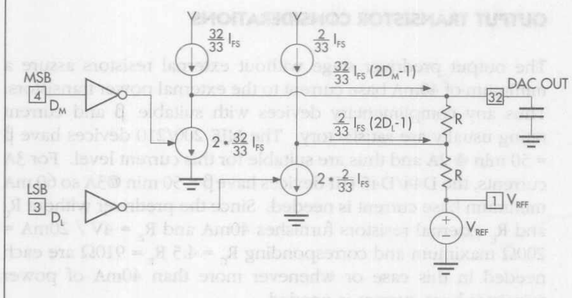


FIGURE 1 — LOGIC TO ANALOG CONVERTER SIMPLIFIED SCHEMATIC

CARRIER RIPPLE FILTER

The preferred way to remove the carrier ripple is by configuring the on-chip buffer amplifier as a Salen Key 3 pole Butterworth low pass filter, as shown in the block diagram.

The normalized transfer function of such a filter is:

$$\frac{1}{\left(\frac{S}{W_O}\right)^3 + 2\left(\frac{S}{W_O}\right)^2 + 2\left(\frac{S}{W_O}\right) + 1}$$

If the clock frequency is 40MHz then the frame rate and lowest carrier ripple frequency of the MSB and LSB signals is 40MHz/64 = 625kHz. Assuming f_O is chosen to be 35 kHz, then $W_O = 2\pi * 35 * 10^3$. For an overall system bandwidth of 500 Hz, the filter introduces only a -2° phase shift yet it rejects the 625 kHz carrier freq by -74 dB.

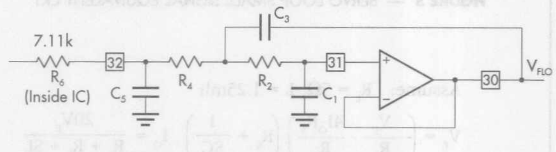


FIGURE 2 — 3RD ORDER SALEN KEY LPF FILTER

The component values selected here set the corner frequency at 35kHz.

R_4 = 35.7 kΩ (1%) R_2 = 10.7 kΩ (1%)
$C_5 = C_3$ = 680pF (5%) C_1 = 82 pF (5%)
R_6 = Thevnin equivalent resistance of the internal circuit (7.11k typ)

If a different cutoff frequency is desired, the values of the capacitors can be scaled proportionally and Butterworth response will be retained if the R values are kept constant at the values given. Below is the transfer function of the above filter.

$$\left[\frac{1}{\left\{\begin{array}{c} S^3R_6C_5R_4C_3R_2C_1 + S^2(R_6C_5R_2C_1 + R_6C_5R_4C_1 + R_4C_3R_2C_1 + R_6C_3R_2C_1) \\ + S(R_6C_5 + R_6C_1 + R_4C_1 + R_2C_1) + 1 \end{array}\right\}}\right]$$

LINFINITY MICROELECTRONICS

APPLICATION INFORMATION (continued)

CLOSED LOOP TRANSCONDUCTANCE AND FREQUENCY RESPONSE

Figure 3 shows the small signal model of the VCM servo loop.

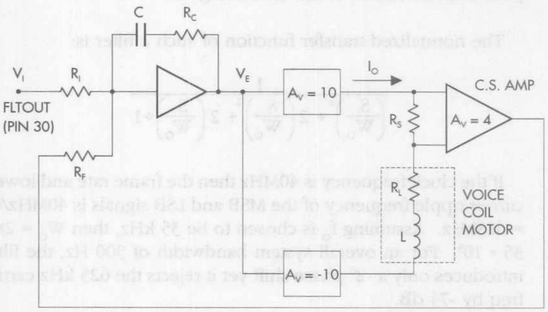


FIGURE 3 — SERVO LOOP SMALL SIGNAL EQUIVALENT CKT

Assume: $R_L = 5\Omega$, $L = 1.25mh$

$$V_E = \left(-\frac{V_I}{R_I} - \frac{4I_O R_S}{R_F}\right)\left(R_C + \frac{1}{SC}\right),\ I_O = \frac{20V_E}{R_S + R_L + SL}$$

$$\therefore \left(\frac{R_S + R_L + SL}{20}\right) I_O = \left(\frac{V_I}{R_I} - \frac{4I_O R_S}{R_F}\right)\left(R_C + \frac{1}{SC}\right)$$

$$\frac{I_O}{V_I} = \left(\frac{R_C + \frac{1}{SC}}{R_I}\right) * \frac{20R_F}{\left[R_F\,(R_S+R_L+SL) + 80R_S\left(R_C + \frac{1}{SC}\right)\right]}$$

$$= \frac{20\,\frac{R_F}{R_I}}{\left[80R_S + \frac{R_F\,CS\left(1 + \frac{L}{R_S+R_L}S\right)\left(R_S + R_L\right)}{(1 + R_C\,CS)}\right]}$$

Thus the static closed loop transfer function ($S \rightarrow 0$) is:

$$\frac{I_O}{V_I} = \frac{R_F}{4R_S R_I}$$

And since V_I is $\pm V_{REF}/2$ ($\pm$ 2.0V typ of full scale), then $\pm I_O$ full scale = $R_F/(2R_S R_I)$ and for $I_O = \pm 2A$, $\mathbf{R_s = 0.25\Omega}$ is a good choice, (i.e. 0.5V across the sense resistor):

$$\frac{R_F}{R_I} = 2 * 2R_S = 1$$

Now for considerations of closed loop bandwidth, transient response and the required frequency compensation network R_C and C, it is usually advisable to set $R_C C = L/(R_S + R_L)$, i.e. match the compensation and load time constants so the closed loop response is dominantly that of a single pole network:

$$\therefore \frac{I_O}{V_I} = \frac{20\,\frac{R_F}{R_I}}{80R_S + SR_F\,(R_S + R_L)\,C}$$

$$= \frac{R_F}{4R_S\,R_I\left(1 + S\,\frac{R_F\,(R_S + R_L)\,C}{80\,R_S}\right)}$$

$$\text{so that } f_O = \frac{80R_S}{2\pi\,R_F\,(R_S + R_L)\,C}$$

where f_o is the closed loop -3db bandwidth.

Assuming $R_F = R_I = 10k$, for $f_O = 20kHz$, the value of C is calculated using:

$$C = \frac{80 * 0.25}{10 * 10^3\,(0.25 + 5) * 2\pi * 20 * 10^3},\ \mathbf{C = 0.0033\mu f}$$

$$\text{and since } R_C = \frac{L}{(R_S + R_L)\,C},\ R_C = \frac{1.25 * 10^{-3}}{5.25 * 0.0033 * 10^{-6}} \cong \mathbf{72k\Omega}$$

OUTPUT TRANSISTOR CONSIDERATIONS

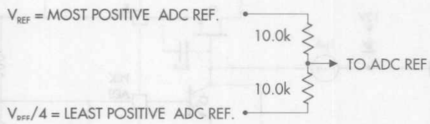
The output predriver stage without external resistors assure a minimum of 40mA base current to the external power transistors. Thus any complimentary devices with suitable β and current rating usually are satisfactory. The MJE 200/210 devices have β = 50 min @ 2A and thus are suitable for this current level. For 3A currents, the D44/D45 HII devices have β = 50 min @3A so 60 mA minimum base current is needed. Since the predriver without R_C and R_E external resistors furnishes 40mA and R_E = 4V / 20mA = 200Ω maximum and corresponding $R_C = 4.5\ R_E \approx 910\Omega$ are each needed in this case or whenever more than 40mA of power transistor base current is needed.

Suitable surface-mount power devices include: BCX 68-69, BCP 68-69, 2SD 2098-2SB 1386, MJD 44HII-45HII, MJD 200-210.

APPLICATION INFORMATION (continued)

CURRENT SENSE AMPLIFIER

The additional current sense amplifier is used to provide actual measured motor current feedback to the controller. It is ordinarily used with an analog to digital converter that uses the same V_{REF} = 4V as the 3187 for its full scale most positive reference and ordinarily 1V (V_{REF} /4) as its least positive reference. Thus the voltage for 0 current at half scale is $[V_{REF} + (V_{REF}/4)] / 2 = 2.5V$, which should be "ADC REF" of the 3187. This can be obtained by two equal value resistor divider of convenient value such as 10kΩ between the most positive and least positive reference voltages, since the ADC REF pin is buffered for high impedance inputs.



Then Diff-Amp out voltage = ADC REF $\pm 3I_oR_s$.

POWER-ON RESET

The $\overline{POR}$ is an open collector output that switches low when either V_{CC} or V_{DD} are below their thresholds of 10.3V and 4.6V respectively. At the same time, an internal transistor discharges the POR-DELAY capacitor. When power returns both comparators are above their thresholds, the POR latch gets reset and allows the delay capacitor to charge up via an internal current, causing a delay of 100 ms/µf typ before the POR switches HI again (POR pin requires a maximum 100k pull up resistor). In our previous example, 0.47µf capacitor allows a typical of 100ms which is adequate for most applications.

MODE SELECT FUNCTION

The figure below shows the internal logic circuitry for "Mode Select." When this pin is set low, both comparators output switch LO and the output of park "AND" gate goes HI which enables the park function. If the mode select pin is left open, comparator "A" switches LO but comparator "B" is HI which enables the "disable" mode. In this mode all functions are disabled except for the POR circuit, PWM DAC and the PARK circuit. When the mode select pin is HI, both "AND" gates are LO and the device resumes its normal operation.

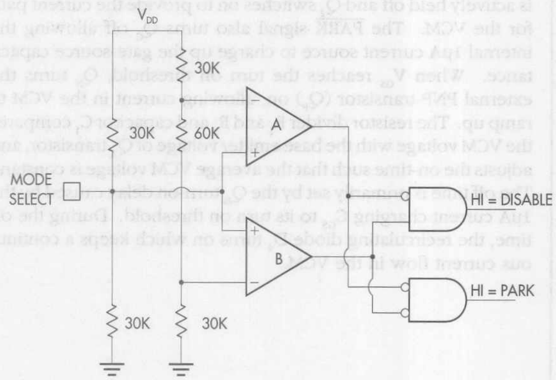


FIGURE 5 — MODE SELECT COMPARE LOGIC CIRCUITRY

APPLICATION INFORMATION (continued)

PARK CIRCUIT

The LX3187 has a unique "switching mode" PARK circuit which allows in excess of 200mA PARK current with less package power dissipation when compared to the standard linear mode circuits used in most VCM controllers.

The voice coil head park is initiated by loss of either supplies which is indicated by the $\overline{\text{POR}}$ pin switching LO or when mode select is pulled low. Referring to the main block diagram, when either of the " $\overline{\text{POR}}$ " or "mode select" pins are set low, PARK switches high and enables the park circuit shown in figure 6.

During park mode, PNP transistors Q_1 and Q_3 are turned off, Q_4 is actively held off and Q_2 switches on to provide the current path for the VCM. The $\overline{\text{PARK}}$ signal also turns Q_C off allowing the internal 1µA current source to charge up the gate-source capacitance. When V_{GS} reaches the turn on threshold, Q_N turns the external PNP transistor (Q_P) on, allowing current in the VCM to ramp up. The resistor divide R_1 and R_2 and capacitor C_1 compares the VCM voltage with the base emitter voltage of Q_A transistor, and adjusts the on-time such that the average VCM voltage is constant. The off time is primarily set by the Q_N turn-on delay caused by the 1µA current charging C_{GS} to its turn on threshold. During the off time, the recirculating diode D_4 turns on which keeps a continuous current flow in the VCM.

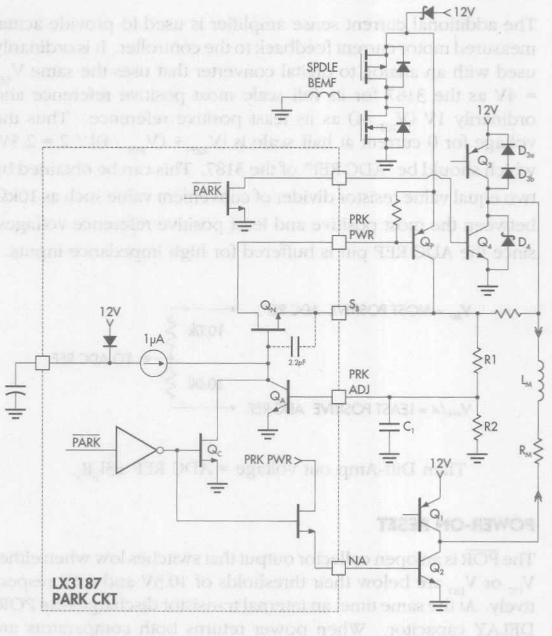


FIGURE 6 PARK CIRCUIT SIMPLIFIED CIRCUIT

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

LX3191B

HALL-LESS SPINDLE MOTOR DRIVER

PRELIMINARY DATA SHEET

DESCRIPTION

The LX3191B is a monolithic BiCMOS IC designed to control speed and commutation of a Hall-less 3-phase motor used in many high-performance data storage devices. Special circuitry allows accurate digital commutation control in conjunction with precise current wave shaping that allows substantial reduction in acoustic motor noise. This device includes a serial interface that enables the user to select different modes of operation by a 16-bit word with a direct interface to the microcontroller. High-speed operation is achieved through bipolar start-up for increased starting torque. PWM operation during start-up to minimize power dissipation is available. The LX3191B is designed to drive external low side n-channel FETs, and high side p-channel FETs, such as the ones available as complimentary P and N channel devices in 8-pin SOIC packages as shown in the product highlight. A full evaluation board is available for application development.

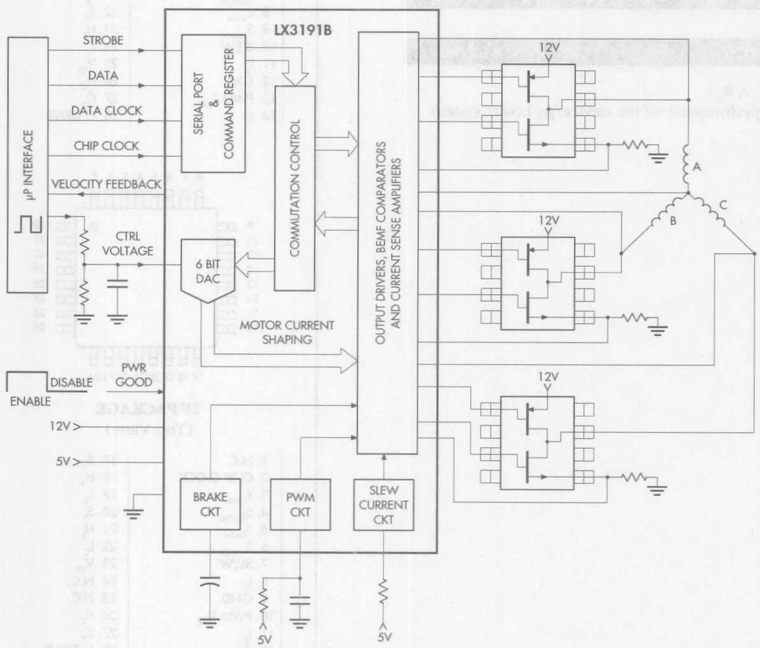
KEY FEATURES

- **SERIAL DATA CONTROL INTERFACE** CONTROLS ARE:
  - Trapezoidal shape motor current
  - Brake function via serial interface & power down
  - Start-up start advancing
  - External / Internal BEMF commutation
  - PWM / Linear Mode
- **EXTERNAL POWER DRIVE ALLOWS:**
  - Higher efficiencies due to much smaller available R_{DS} on resistance (now available from many sources)
  - Higher headroom voltage allows smaller motor design
- BIPOLAR PWM START REDUCES START UP POWER DISSIPATION OF LOW SIDE FETS
- TRAPEZOIDAL CURRENT SHAPE CONTROL REDUCES MOTOR ACOUSTIC NOISE, ELMINATES SNUBBER
- SEPARATE SENSE RESISTORS COMPENSATE FOR EXTERNAL TRANSISTOR MISMATCH AND ACCURATE COMMUTATION CONTROL
- POWER GOOD, BRAKE DELAY, EXTERNAL FREQUENCY PWM OFF TIME CONTROL

APPLICATIONS

- HIGH-PERFORMANCE / HIGH-SPEED MULTIPLE PLATTER 3½" & 5¼" DRIVES. (i.e. 7200 rpm, 10 platters)
- EVALUATION BOARD AVAILABLE

PRODUCT HIGHLIGHT



PACKAGE ORDER INFORMATION

T_A (°C)	Q Plastic PLCC 28-pin	TF Plastic TQFP 32-pin
0 to 70	LX3191BQ	LX3191BTF

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

LX3191B

HALL-LESS SPINDLE MOTOR DRIVER

PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Notes 1 & 2)

V_{DD} Voltage 5.5V
V_{CC} Voltage 14V
$V_{RETRACT}$ Voltage 14V
Current Sense Voltage - Pins 11, 14, 17 .... -0.3V to +4V
Logic Input Voltage - Pins 2, 5, 7, 8, 9 .... -0.3V to V_{DD} +0.3V
Control Voltage, V_{CTRL} .... -0.3V to V_{DD} +0.3V
Storage Temperature Range .... -65°C to +150°C
Lead Temperature (Soldering, 10 Seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.
Note 2. Pin numbers refer to PLCC package.

THERMAL DATA

Q PACKAGE:

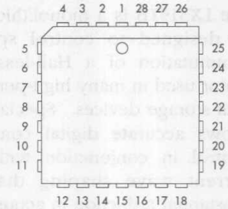
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	70°C/W

TF PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	81°C/W

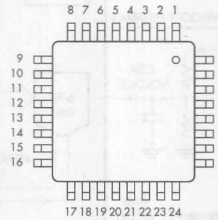
Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

PACKAGE PIN OUTS



Q PACKAGE
(Top View)

1. $V_{RETRACT}$	15. S_A
2. POWER GOOD	16. V_{CTRL}
3. B_{DLY}	17. I_A
4. V_{DD}	18. L_A
5. CHIP CLOCK	19. S_C
6. F_{COM}	20. H_A
7. S_{STROBE}	21. L_B
8. S_{DATA}	22. S_B
9. S_{CLOCK}	23. H_B
10. SLEW	24. L_C
11. I_C	25. V_{CC}
12. GND	26. H_C
13. PWM T_{OFF}	27. C_T
14. I_B	28. C_T DRIVE



TF PACKAGE
(Top View)

1. N.C.	17. S_C
2. CHIP CLOCK	18. H_A
3. F_{COM}	19. L_B
4. S_{STROBE}	20. S_B
5. S_{DATA}	21. H_B
6. S_{CLOCK}	22. L_C
7. SLEW	23. V_{CC}
8. I_C	24. N.C.
9. GND	25. N.C.
10. PWM T_{OFF}	26. H_C
11. I_B	27. C_T
12. S_A	28. C_T DRIVE
13. V_{CTRL}	29. $V_{RETRACT}$
14. I_A	30. POWER GOOD
15. N.C.	31. B_{DLY}
16. L_A	32. V_{DD}

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 3)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
V_{DD} Voltage		4.75		5.25	V
V_{CC} Voltage, $V_{RETRACT}$		10.8		13.2	V
V_{CTRL} Voltage				V_{DD}	V
PWM Timing Capacitor	C_T	1000pF		0.01µF	
PWM Timing Resistor	R_T	10		100	kΩ

Note 3. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of 0°C ≤ T_A ≤ 70°C and V_{DD} = 5V, V_{CC} = 12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.) Pin numbers refer to PLCC package.

Parameter	Symbol	Test Conditions	LX3191B			Units
			Min.	Typ.	Max.	
Logic and Power Good Input Section (Pins 2, 5, 7, 8, 9)						
High Input Voltage	V_{IH}		2.4			V
High Input Current	I_{IH}	$2.4 < V_{IH} < 5.5V$		20	200	nA
Low Input Voltage	V_{IL}				0.8	V
Low Input Current	I_{IL}	V_{IL} = 0.4V		20	200	nA
Input Capacitance		Pins 5, 7, 8, 9		3		pF
		Pin 2		10		pF
Clock Frequency	F_{CLK}	Pin 5			10	MHz
F_{COM} Output Section (Pin 6)						
High Output Voltage		I_O = 1mA	2.4			V
Low Output Voltage		I_O = 1mA			0.4	V
Retract Section (Pin 1), $V_{DD} = V_{CC}$ = 0V						
Input Current		$V_{RETRACT}$ = 13.2V		1.2	1.75	mA
Brake Delay Section (Pin 3)						
Charge Current	I_{CH}	Pin 2 = HIGH	300	700	850	µA
Discharge Current	I_{D1}	Pins 18, 21, 24 OPEN; Pin 2 = LOW, Pin 3> 7.7V, $V_{CC} = V_{DD}$ = 0V		72		µA
	I_{D2}	Pins 18, 21, 24 OPEN; Pin 2 = LOW, Pin 3 ≤ 6V, $V_{CC} = V_{DD}$ = 0V		10	20	µA
Retract Delay Constant	T_{D1}	$V_{TH} < V_{BRAKE} < 10.5V$	15	60		ms/µF
Peak Charge Voltage	V_P		11.35	V_{CC}-0.3		V
Threshold Voltage	V_{TH}		6.7	7	7.5	V
Slew Section (Pin 10) (Note 4)						
Slew Input Impedance	R_I	$100µA \le I_{SLEW} \le 300µA$	2.5	3.8	5.5	kΩ
Output Current to Slew Current Gain	K	$100µA \le I_{SLEW} \le 300µA$	1.5	1.8	2.2	
Speed Control Section (Pin 16)						
Operating Voltage Range	V_{CTRL}		0		3.5	V
Input Bias Current		$1V < V_{CTRL} < 5.5V$	-2		1	µA
Control Voltage Shutdown Threshold	V_{OFS}		50			mV
Control to C.S. Gain, PWM and Linear	G	Gain = $\Delta V_{PIN16} / \Delta V_{C.S.}$, $0.5V < V_{CTRL} < 3.5V$	5.1	5.9	6.8	V/V
Gain Matching (Note 5)		Between channels A, B, C; $0.5V < V_{CTRL} < 3.5V$	-10		+10	%
Gain Matching		Between PWM to Linear Mode, $0.5V < V_{CTRL} < 3.5V$	0		6	%

ELECTRICAL CHARACTERISTICS (Continued)

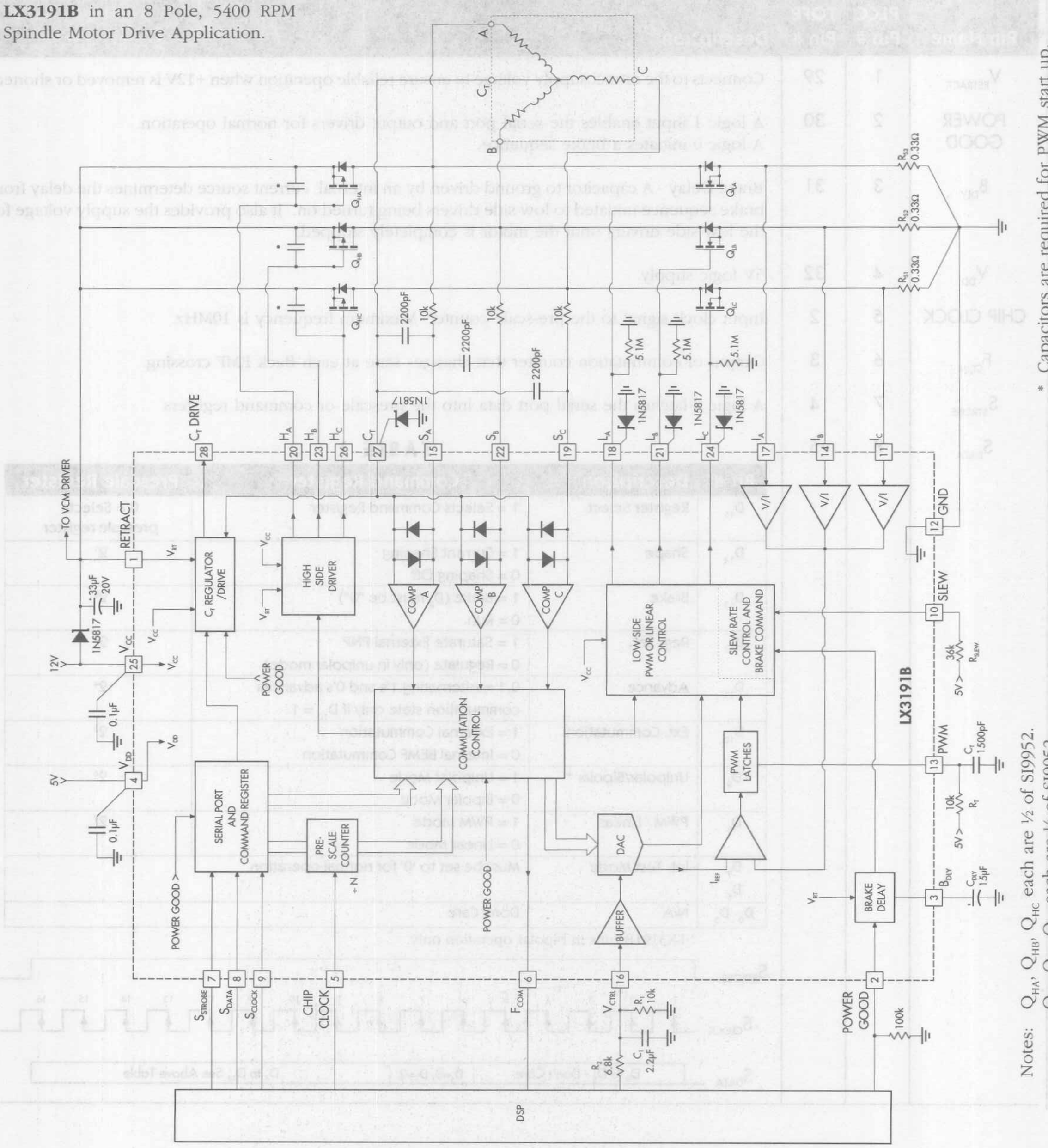
Parameter	Symbol	Test Conditions	LX3191B Min.	LX3191B Typ.	LX3191B Max.	Units
PWM Section (Pin 13)						
Minimum Off Time	$T_{OFF\ MIN}$		5			µs
Comparator Bias current		During charge time, $V_{PWM} = 2.5V$	-3	-0.8	0.5	µA
Discharge Current	I_{DP}		2.5	5	7	mA
Upper Threshold Voltage	V_U		2.9	3	3.1	V
Lower Threshold Voltage	V_L			1		V
Clamp Voltage, Low		$I_{SOURCE} = 100µA$	0.25	0.5	0.6	V
C_T Pin (Pin 27)						
Input Impedance		$V_{CT} < 10.5V$	160			KΩ
Back EMF Comparators (Pins 15, 19, 22)						
Input Offset Voltage	V_{IO}	$4.5V < C_T < (V_{CC}-1.5)$			±15	mV
Clamp Voltage	V_{CLP}	$I = \pm 2mA$	0.6		1.2	V
Input Current	I_I	$\lvert V_{IN} \rvert < 0.5V$, $4.5V < C_T < V_{CC} - 1.5V$	-1.5		1.5	µA
Maximum Input Current	I_{IMAX}				±10	mA
Current Sense Comparators (Pins 11, 14, 17)						
Input Bias Current	I_{BCS}	$0V < V_{CS} < 0.7V$	-135		-65	µA
Input Voltage Range			-0.3		4	V
Operating Voltage Range			0		$V_{CS\ MAX}$	V
Maximum Current Sense Voltage	$V_{CS\ MAX}$	$V_{CTRL} = 3.2V$, $V_{DD} = 4.75V$	0.48	0.55	0.61	V
High Side Output Driver Section (Pins 20, 23, 26)						
Output Voltage Low		$I = 100µA$		0.95	1.25	V
Output Voltage High		$I = -50µA$	11.5	V_{PIN1}-0.2		V
Output Source Current (turn off)		$V_{OH} = 10V$	400	500		µA
Output Sink Current (turn on)		$V_{OL} = 10V$	170	250		µA
Low Side Output Driver Section (Pins 18, 21, 24) Note 5. See Pin Description Section for I_{SLEW} formula.						
Output HI Voltage		Linear Mode, $I_{SLEW} = 100µA$	10	V_{CC}-0.2		V
		PWM Mode, $I_{SOURCE} = 5mA$	9	V_{CC}-1.5		V
Output Source Current (Note 5)	I_{SLH}	Linear Mode, $I_{SLEW} = 100µA$, $V_{OH} = 1V$	150	200	220	µA
		Linear Mode, $I_{SLEW} = 300µA$, $V_{OH} = 1V$	450		660	µA
		PWM Mode, $V_{OH} = 5V$	10	25		mA
Output LO Voltage		Linear Mode, $I_{SLEW} = 100µA$		0.1	0.5	V
		PWM Mode, $I_{SINK} = 5mA$		1.0	1.50	V
Output Sink Current (Note 5)	I_{SLL}	Linear Mode, $I_{SLEW} = 100µA$, $V_{OL} = 3V$	150	200	220	µA
		Linear Mode, $I_{SLEW} = 300µA$, $V_{OL} = 3V$	450		660	µA
		PWM Mode, $V_{OL} = 2V$	15	20		mA
Output Current Source to Sink Ratio		$100µA < I_{SLEW} < 300µA$	1		1.25	µA/µA
Output Off Leakage Current		$P_{GOOD} = LO$, $V_{BRAKE} > 7.7V$, $V_{OL} = 0.5V$, $V_{CC} = V_{DD} = 0V$			200	nA
Power Supply Section (Pins 4, 25)						
V_{DD} Supply Current		$P_{GOOD} = 1$		10	12	mA
V_{CC} Supply Current		$P_{GOOD} = 1$		10	12	mA

Note 4. Slew input impedance is calculated as; $R_I = \frac{V_{PIN10} - V_{BE}}{I_{PIN10}}$
where; V_{PIN10} ≡ Voltage at pin 10.
I_{PIN10} ≡ Current measured at pin 10.
V_{BE} ≡ Base-emiter voltage. (typ 0.65v at room temp)

Note 5. Gain Match = $\frac{G_{MAX} - G_{MIN}}{G_{MAX} + G_{MIN}} * 100\ (\%)$

BLOCK DIAGRAM

LX3191B in an 8 Pole, 5400 RPM Spindle Motor Drive Application.



Notes: Q_{HA}, Q_{HB}, Q_{HC} each are ½ of SI9952.
Q_{LA}, Q_{LB}, Q_{LC} each are ½ of SI9952

* Capacitors are required for PWM start up.

LINFINITY MICROELECTRONICS

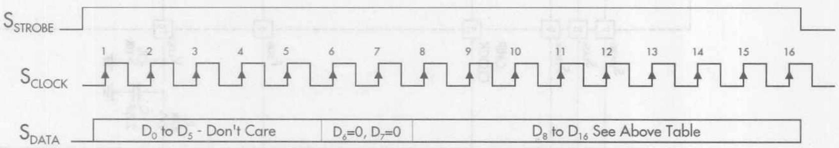
FUNCTIONAL PIN DESCRIPTIONS

Pin Name	PLCC Pin #	TQFP Pin #	Description
$V_{RETRACT}$	1	29	Connects to the retract supply voltage to ensure reliable operation when +12V is removed or shorted.
POWER GOOD	2	30	A logic 1 input enables the serial port and output drivers for normal operation. A logic 0 initiates a brake sequence.
B_{DLY}	3	31	Brake Delay - A capacitor to ground driven by an internal current source determines the delay from brake sequence initiated to low side drivers being turned on. It also provides the supply voltage for the low side drivers until the motor is completely stopped.
V_{DD}	4	32	5V logic supply.
CHIP CLOCK	5	2	Input clock signal to the pre-scale counter. Maximum frequency is 10MHz.
F_{COM}	6	3	Output of commutation counter that changes state at each Back EMF crossing.
S_{STROBE}	7	4	A logic 0 latches the serial port data into the prescale or command registers
S_{DATA}	8	5	See TABLE 1 below

TABLE 1

Bit #	Description	Command Register	Prescale Register
D_{15}	Register Select	1 = Selects Command Register	0 = Selects prescale register
D_{14}	Shape	1 = Current Shaping 0 = Shaping Off	2^1
D_{13}	Brake	1 = Brake (D_8 must be "0") 0 = Run	2^2
D_{12}	Reg. Sat.	1 = Saturate External PNP 0 = Regulate (only in unipolar mode)	2^3
D_{11}	Advance	0,1 = Alternating 1's and 0's advances commutation state only if D_{10} = 1	2^4
D_{10}	Ext. Commutation	1 = External Commutation 0 = Internal BEMF Commutation	2^5
D_9	Unipolar/Bipolar *	1 = Unipolar Mode 0 = Bipolar Mode	2^6
D_8	PWM / Linear	1 = PWM Mode 0 = Linear Mode	2^7
D_7 D_6	Int. Test Mode	Must be set to '0' for normal operation	
D_0 - D_5	N/A	Don't Care	

* LX3191B runs in bipolar operation only.



LINFINITY MICROELECTRONICS

FUNCTIONAL PIN DESCRIPTIONS (continued)

Pin Name	PLCC Pin #	TQFP Pin #	Description
S_{CLOCK}	9	6	A low to high transition clocks data into the serial port.
SLEW	10	7	A resistor between the slew pin and 5V supply establishes the maximum current to slew the gates of the N-channel FETs On/Off. Output Slew Current (mA) = $k \bullet (V_{DD} - V_{BE}) / (R_{SLEW} + R_I)$. Where: $R_{SLEW} \equiv$ External resistor connected to V_{DD}; $R_I \equiv$ Internal resistor, $2.5k < R_I < 4.5k$; $V_{BE} \equiv$ Base emitter voltage; $k \equiv$ Output current to slew current gain $1.5 < k < 2.2$.
I_A, I_B, I_C	17, 14 11	14, 11 8	Senses motor current to complete the transconductance loop. Relationship between motor current and V_{CTRL} is given by; $I_{MOTOR} = (V_{CTRL} - V_{OFS}) / G \bullet R_S$, and maximum motor current is calculated using: $I_{MAX} = V_{CSMAX} / R_S$, where; $G \equiv V_{CTRL}$ to Current Sense Gain, $R_S \equiv$ Sense Resistor, $V_{OFS} \equiv V_{CTRL}$ to $V_{C.S.}$ Offset.
GROUND	12	9	
PWM T_{OFF}	13	10	A resistor to 5V and capacitor to ground determines the fixed "off time" in PWM mode. $T_{OFF} \approx 0.7 \bullet R_T \bullet C_T$ ($T_{OFF(MIN.)} = 5\mu sec$)
S_A, S_B, S_C	15, 22 19	12, 20 17	Comparators inputs used to sense BEMF.
V_{CTRL}	16	13	Voltage input that controls motor current.
L_A, L_B, L_C	18,21 24	16,19 22	Low side drivers for both linear and PWM control of external N-channel FET gates.
H_A, H_B, H_C	20,23 26	18,21 26	High side drivers enabled during bipolar drive that control the gates of external P-channel FETs.
V_{CC}	25	23	10.8 - 13.2V. Analog supply.
C_T	27	27	Input pin that connects to the centertap of the spindle motor.
C_T DRIVE	28	28	This pin must be left open.
		1,15 24,25	No connection internally.

HALL-LESS SPINDLE MOTOR DRIVER

PRELIMINARY DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE #

FIGURE INDEX

IC Description

FIGURE #

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — V_{CTRL} OFFSET VOLTAGE vs. JUNCTION TEMPERATURE

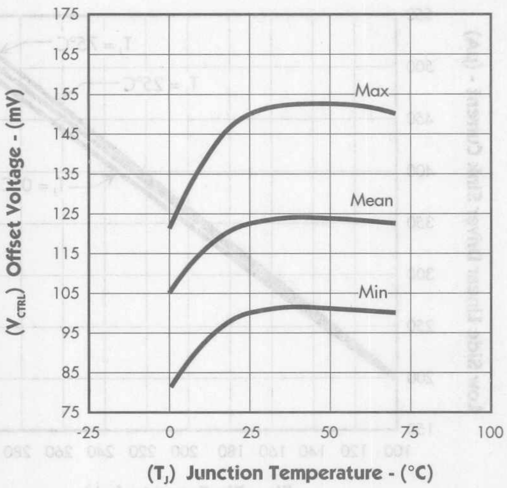


FIGURE 2. — CURRENT SENSE VOLTAGE vs. V_{CTRL}

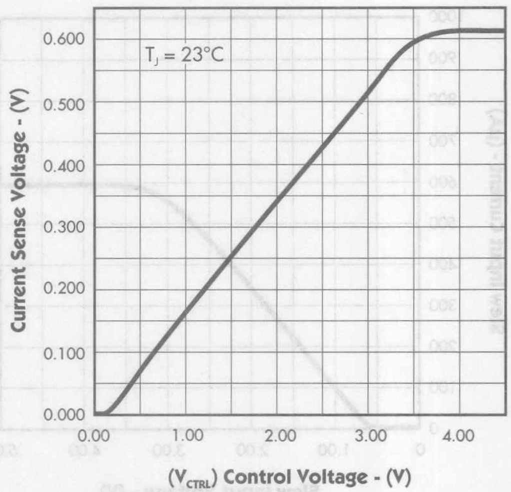


FIGURE 3. — BRAKE THRESHOLD VOLTAGE vs. JUNCTION TEMPERATURE

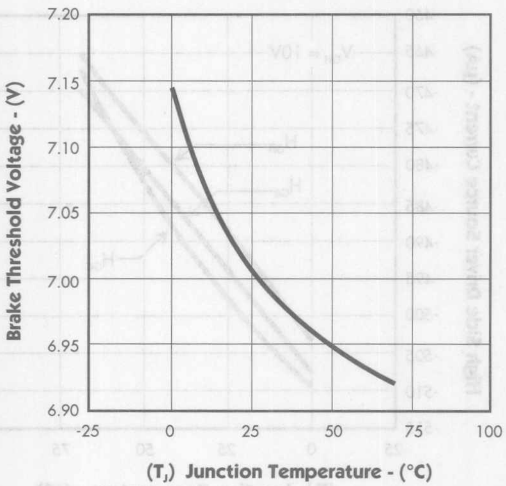
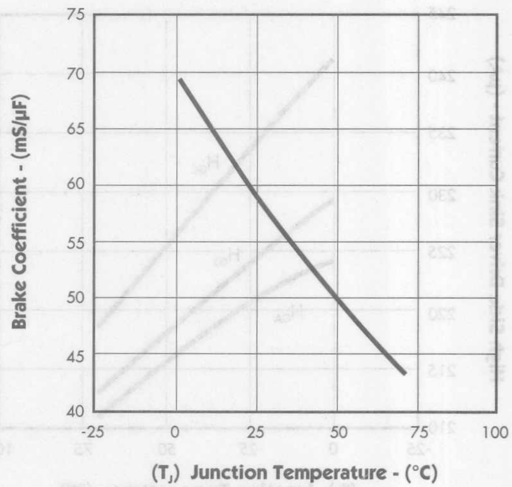


FIGURE 4. — BRAKE DELAY TIME COEFFICIENT vs. JUNCTION TEMPERATURE



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — SLEW INPUT CURRENT vs. SLEW INPUT VOLTAGE

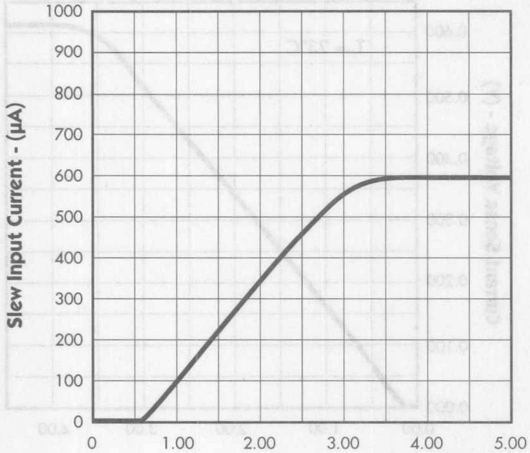


FIGURE 6. — LOW SIDE LINEAR DRIVER SINK CURRENT vs. SLEW PIN CURRENT

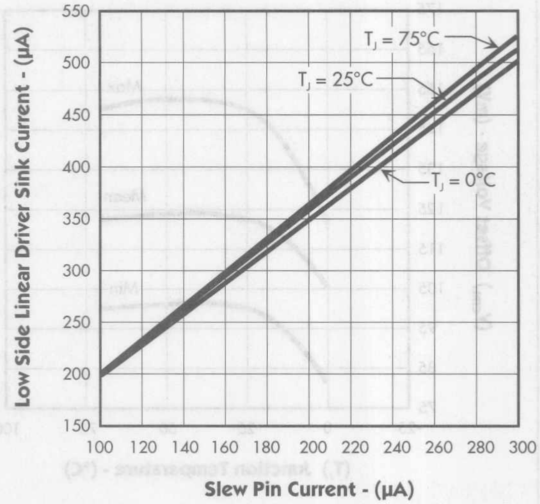


FIGURE 7. — HIGH SIDE DRIVER SINK CURRENT vs. TEMPERATURE

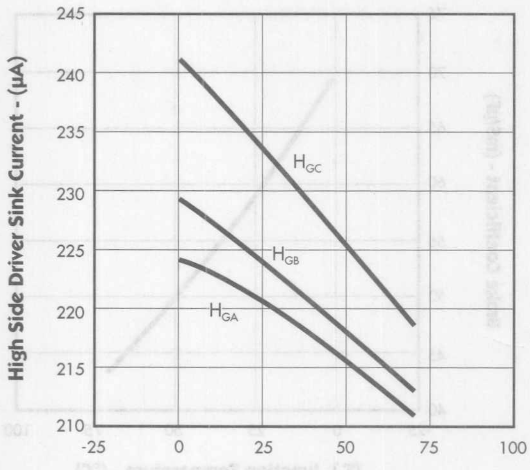
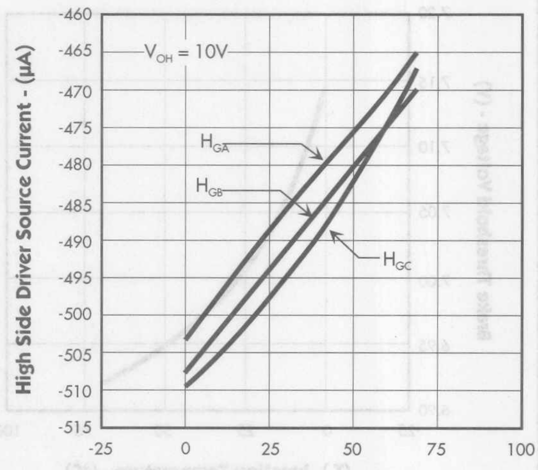


FIGURE 8. — HIGH SIDE DRIVER SOURCE CURRENT vs. TEMPERATURE



LINFINITY MICROELECTRONICS

APPLICATION NOTES

PRESCALE COUNTER

This part has digital commutation control driven by the master clock through the prescale counter. At normal motor operating speed, there should be exactly 128 cycles of the output from the prescale counter during each 1/6 of an electrical commutation cycle. If P is the number of motor poles then there are P/2 electrical commutation cycles per mechanical shaft revolution and the prescale counter output frequency is given by:

$$\frac{\text{mechanical RPM}}{60} \bullet \frac{P}{2} \bullet 6 \bullet 128 = F_{PRESCALE}$$

example: @5400 RPM, 8 pole motor:

$$F_{PRESCALE} = \frac{5400}{60} \bullet 4 \bullet 6 \bullet 128 = 276.48 \text{ kHz}$$

The prescale counter consists of a fixed divide by 2 cascaded with a down counter which is repetitively loaded with the value N in the prescale register of the serial port and counted up to all 1's. Thus the total prescale frequency division from the master clock input is 2•(N+1). Thus for the example above with a master clock of 10MHz:

$$2(N+1) = \frac{10 \bullet 10^6}{276.48 \bullet 10^3}, \; N + 1 = 36.18, \Rightarrow N = 17$$

Although at operating speed 7 bits are normally used, the actual size of the commutation counter is 10 bits, so the lowest speed that can be precisely internally commutated is $1/2^3 = 1/8$ of the operating speed, unless the prescale counter is reprogrammed on the fly between startup and steady state run.

SERIAL INTERFACE INPUT

All logic level control inputs to the LX3191B are made through a three wire serial interface that may be clocked at rates up to 10MHz. Data is entered as two 16 bit words, most significant bit first and word select bit last (See Table 1 in Functional Pin Description Section).

One 16 bit word sets the division factor of the on chip prescale divider between the clock (pin5) and the internal commutation counters. As noted earlier, for proper operation of the current shaping as well as the commutation functions, the internal clock frequency should have 128 cycles during 60° electrical at steady state running speed. Therefore: $F_{INT\ CLOCK}$ = 128 • RPM/60 • Poles/ 2 • 360/60, and prescale divisor, D = Chip Clock (pin5)/$F_{INT\ CLOCK}$. The prescale counter is 8 stage binary with its least significant stage always enabled with a divisor of 2. The 16 bit is loaded per Table- 1 in the Functional Pin Description Section. N = (D/2 - 1), is entered as negatve true logic, i.e. logic low for binary ones. For example, if Chip Clock (pin5) = 10MHz (the maximum permitted frequency) and the motor has 8 poles running at 5400 RPM, then:

$$D = \frac{10 \bullet 10^6}{128 \bullet \frac{5400}{60} \bullet \frac{8}{2} \bullet \frac{360}{60}} = 36.196,$$

and N = (D/2 -1) = (36/2 - 1) = 17. Thus the prescale word would be sent to the serial port as negative true with MSB loaded first.

D_8 ... D_{14} D_{15}

1 1 0 1 1 1 0 0

Where:

$D_8 \rightarrow D_{14}$ represents 17 as negative true word.

D_{15} is the word select bit = 0 for selecting pre-scale.

$D_0 \rightarrow D_7 = 0$

The other serial port word (command) contains seven control bits as shown in Table 1, under the Functional Pin Description Section.

COMMUTATION

Perhaps the most essential function in a sensorless, brushless motor controller is commutation. The requirements are better understood by referring to Figure 9.

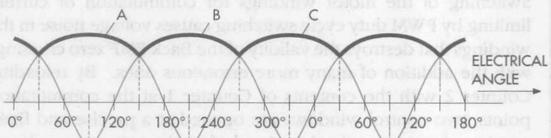


FIGURE 9 — MOTOR TORQUE WAVEFORM

The fundamental principle of Back EMF sensorless commutation is that one of the three windings always has zero current when its voltage, generated with respect to the neutral, passes through zero. Thus by placing comparators from each of the phase voltages with respect to neutral, logic signal edges are obtained at 0°, 60°, 120°, and 180° electrical degrees. Also note that switching signals for commutation are required at 30°, 90°, 150°, and 210°, or halfway between the phase voltage zero crossings. Obtaining the commutation signals from the zero crossings in the LX3191B is done with two counters as shown in Figure 10 on the next page.

APPLICATION NOTES (continued)

COMMUTATION (continued)

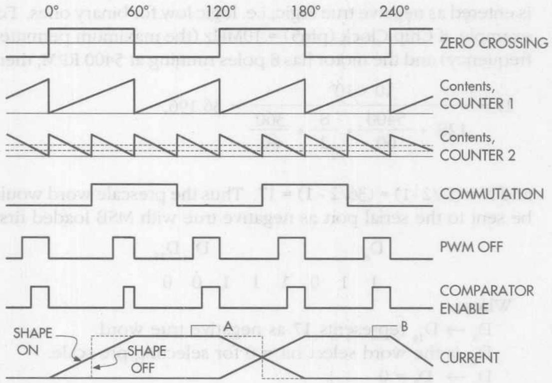


FIGURE 10 — COMMUTATION TIMING DIAGRAM

Counter #1 is reset at the zero crossings and counts up. Counter #2 is loaded with ½ the contents of Counter #1 just before it is reset; when it counts down to zero the commutation point is defined as ½ the time between the previous two crossings, independent of the actual time which is dependent on motor speed.

PWM START UP

Switching of the motor windings for commutation or current limiting by PWM duty cycle switching causes voltage noise in the windings that destroys the validity of the Back EMF zero crossings with the addition of many more erroneous ones. By reloading Counter 2 with the contents of Counter 1 at the commutation points, two control windows are opened at a precise and fixed number of counts or absolute time before the next expected zero crossing. At the PWM off window (20 prescale clocks before the anticipated zero crossing), the PWM modulator is disabled, the system returns to linear mode of operation, to stop its switching noise. After 14 clock cycles the zero crossing window opens and comparator outpus are gated on to look for the next true zero crossing. By use of digital counters rather than analog integrators for these functions, the window accuracy can be held so tight that pwm current limiting becomes practical without adverse effects on commutation accuracy.

It is important to allow enough time for the system's current loop to settle when the PWM to linear switch over occurs. Failure to do this allows the wrong BEMF comparator to commutate the state due to the motor inductance ringing and coupling that may continue well into the time that the window opens. To avoid this, the prescale counter is loaded with a larger number to redue the internal clock and allow for more timing. This can be done several times as the motor is gaining velocity during the start up.

CURRENT WAVE SHAPING

The contents of counter 1 also drives a multiplying D to A whose analog reference input is the control voltage for setting the motor current for speed control. By using the true and complement outputs of the D to A, trapezoidal waveform current references are obtained for the phase currents while maintaining the cross over point accurately at the true commutation point regardless of current magnitude. This is not possible with current profiling methods that fix the current slew rate to obtain "soft switching." By shifting the current gradually between windings, the point of application of the reaction torque to the motor stator windings also moves gradually rather than abruptly, greatly reducing acoustic noise.

MOTOR CURRENT SETTING

The motor current is set by the relationship: $I_{MOTOR} = V_{CTRL}/G \cdot R_S$, where R_S is the resistor value connected between each of pins 18, 21, 24, the corresponding NMOS power transistor and ground. V_{CTRL} is the voltage provided on pin 16. The maximum C.S. voltage for V_{CTRL} of 3.2V is a minimum of 0.48V. So the maximum motor current for an R_S of 0.33Ω would be at least 1.45 amps. The control voltage is a digital filter implementation of the speed control algorithm. Since speed control bandwidths are usually 5Hz or less, digital to analog conversion of V_{CTRL} is easily accomplished by a pulse width modulated logic level output from the processor and a first order ripple filter as described in Figure 11.

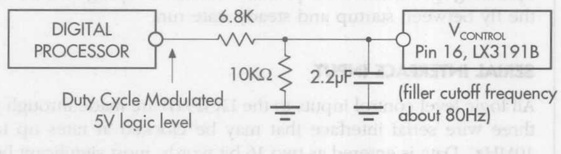


FIGURE 11 PROCESSOR TO V_{CTRL} CONNECTION DIAGRAM

An offset is built into the V_{CTRL} pin that allows zero current when the processor's duty cycle is set at zero.

LINFINITY MICROELECTRONICS

APPLICATION NOTES (continued)

VELOCITY FEEDBACK

The logic level output signal provided on pin 6 of the LX3191B is the zero crossing signal shown in Figure 10. It has a frequency of 3 • (number of poles /2) cycles per mechanical motor revolution. Thus to get a once per revolution speed signal with an 8 pole motor, the frequency of pin 6 (F_{COM}) would be divided by 12 in the speed control processor.

BACK EMF COMPARATORS

The inputs of the Back EMF sensing comparators are differential from input pins 15, 22, and 19 with respect to the neutral at pin 27. There are back to back clamping diodes on the comparator inputs and it is recommended that RC networks as shown in the application figure be used between the motor phase terminals and the comparator inputs. These filters are not part of the commutation algorithm but rather are for limiting the slew rate of the inductive motor switching noise, especially during PWM operation. The comparator inputs are bipolar, so typ resistors in the range of 10 to 20KΩ or smaller should be used in order to minimize the effects of the input bias currents. To avoid timing errors in commutation, the RC time constant should be on the order of 2.5° electrical at run or RC = 60/RPM • 2/Poles • 2.5/360. At 5400 RPM and 8 poles this is about 20µs or 10KΩ and 2200pF.

LOW SIDE DRIVERS

Each of three low side drivers is really three in parallel: a current mode linear driver, a fast switching, high current totempole type voltage mode driver for PWM use, and a PMOS switch for connecting the output to the brake capacitor for brake operation. The linear driver provides symmetrical source and sink current of $1.8 \cdot (V_{DD} - 0.65V) / (R_{SLEW} + 3.8K\Omega)$ where R_{SLEW} is a resistor connected from pin 10 to the 5 volt supply. A reasonable value of current is about 200µA which requires a R_{SLEW} resistor of: $1.8 \cdot 4.35/0.2 \cdot 10^{-3} = R_{SLEW} + 3.8 \cdot 10^3$, $R_{SLEW} = 36K\Omega$.

The voltage mode driver used in PWM mode has high current capabilities of ±20mA for fast switching of the NMOS power transistor gate capacitance.

HIGH SIDE DRIVERS

The positive supply for the high side drivers is the retract line which is the source of the external P-MOS power transistors. During retract there is a constant current of about 500µA and the turn off gate current is about 250µA. This assures a relatively fast switching speed which is still slew limited by the external gate and miller capacitance of the power P-MOS transistors.

BRAKE FUNCTION

The brake function capacitor used on pin-3 of the LX3191 serves two purposes: *1)*. To provide a time delay after loss of supplies as indicated by the power good signal on pin 2 until the brake is applied. This allows the heads to be positioned to the landing zone. *2)*. To provide a source of voltage with the supplies gone for turning on all three of the NMOS power transistors for dynamic braking. When the supplies are present the capacitor is charged to the 12 volt supply. When power good goes false it is discharged by an internal nominal current to a level of about 7 volts, where the current drops to a very small value and the capacitor voltage is applied to the NMOS gate lines by internal PMOS transistors, providing a much longer time for dynamic braking.

In our previous example, a 15µF capacitor provides a nominal delay timer (15µF • 60ms/µF = 900ms) and a typical brake time of about 19 sec.

PWM OFF-TIME CONTROL

The PWM current limit circuit works as a constant off time configuration. The off time is set by a resistor from pin 13 to the +5 supply of 10K typical and a capacitor from pin 13 to ground. The off time is 0.69 RC and maximum recommended frequency is 100KHz. So for an off time of 10µsecond:

$$0.69 \cdot 10^4 \cdot C = 10 \cdot 10^{-6} \Rightarrow C = 14.5 \cdot 10^{-10}F \approx 1500pF$$

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1635/SG3635

2A HALF BRIDGE DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG1635 is a monolithic integrated circuit designed to interface low-level logic signals with high-current, inductive, or capacitive loads. This device is particularly adept at high-speed pulse width modulation for motor drives or Class D audio amplifiers, and when used in pairs, they can provide full bridge drive for bi-directional control.

With TTL-compatible units, this device will either source or sink up to 5A of peak current with interlock protection to insure that source and sink cannot be on simultaneously. Additional protection is provided by thermal shutdown of the source output if the chip temperature rises above 160°C. High speed internal commutating diodes are also included.

KEY FEATURES

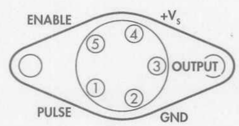
- SOURCE OR SINK 5A PEAK
- HALF-BRIDGE WITH INTERNAL DIODES
- TTL INPUT COMPATIBILITY
- EITHER DUAL OR TRI-STATE OUTPUT
- DIRECT PWM MOTOR DRIVE FROM MICROPROCESSOR
- BUILT-IN THERMAL PROTECTION
- SG3635P REPLACES UDN2935Z

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

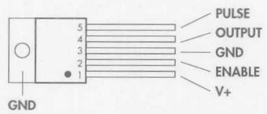
COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



CASE IS GROUND
Case & Tab are internally connected to substrate ground

R PACKAGE
(Top View)



Case & Tab are internally connected

P PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	R Metal Can TO-66 5-pin	P Plastic TO-220 5-pin
0 to 70	SG3635R	SG3635P
-55 to 125	SG1635R	—
MIL-STD-883	SG1635R/883B	—

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG1731/SG2731/SG3731

DC MOTOR PULSE WIDTH MODULATOR

PRODUCTION DATA SHEET

DESCRIPTION

The SG1731 is a pulse width modulator circuit designed specifically for DC motor control. It provides a bi-directional pulse train output in response to the magnitude and polarity of an analog error signal input. The device is useful as the control element in motor-driven servo systems for precision positioning and speed control, as well as in audio modulators and amplifiers using carrier frequencies to 350kHz.

The circuit contains a triangle waveform oscillator, a wideband operational amplifier for error voltage generation, a summing/scaling network for level-shifting the triangle waveform, externally programmable PWM comparators and dual ±100mA, ±22V totem pole drivers with commutation diodes for full bridge output. A $\overline{\text{SHUTDOWN}}$ terminal forces the drivers into a floating high-impedance state when drive LOW. Supply voltage to the control circuitry and to the output drivers may be from either dual positive and negative supplies, or single-ended.

KEY FEATURES

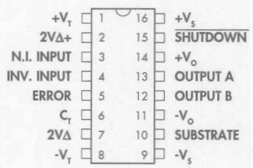
- ±3.5V TO ±15V CONTROL SUPPLY
- ±2.5V TO ±22V DRIVER SUPPLY
- DUAL 100mA SOURCE/SINK OUTPUT DRIVERS
- 5kHz TO 35kHz OSCILLATOR RANGE
- HIGH SLEW RATE ERROR AMPLIFIER
- ADJUSTABLE DEADBAND OPERATION
- DIGITAL $\overline{\text{SHUTDOWN}}$ INPUT

HIGH RELIABILITY FEATURES

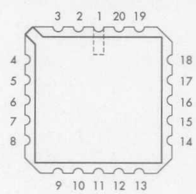
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



1. N.C.
2. V_{T+}
3. $2V_{\Delta+}$
4. N.I. INPUT
5. INV. INPUT
6. N.C.
7. ERROR
8. C_T
9. $2V_{\Delta-}$
10. $-V_T$
11. N.C.
12. $-V_S$
13. SUBSTRATE
14. $-V_O$
15. OUTPUT B
16. N.C.
17. OUTPUT A
18. $+V_O$
19. $\overline{\text{SHUTDOWN}}$
20. $+V_S$

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3731N	SG3731J	—
-25 to 85	SG2731N	SG2731J	—
-55 to 125	—	SG1731J	—
MIL-STD-883	—	SG1731J/883B	SG1731L/883B

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Rev. 1.0 9/95

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG2273/SG3373

POWER OPERATIONAL AMPLIFIER

PRODUCTION DATA SHEET

DESCRIPTION

The SG2273/3273 is a monolithic power operational amplifier, which features a high-current, low-saturation voltage, flyback protected output stage optimized for driving heavily inductive loads. Capable of operation in a single supply mode from as low as 4.5V up to 13.2V, the SG2273/3273 is ideally suited for the computer peripheral environment, driving small motors, solenoids, and linear actuators in an H-bridge configuration.

As a general-purpose op amp, the SG2273/3273 exhibits low input offset voltage, high open loop gain, low quiescent current, a large differential input voltage range, and a common-mode input voltage range, which includes ground (V_{EE}).

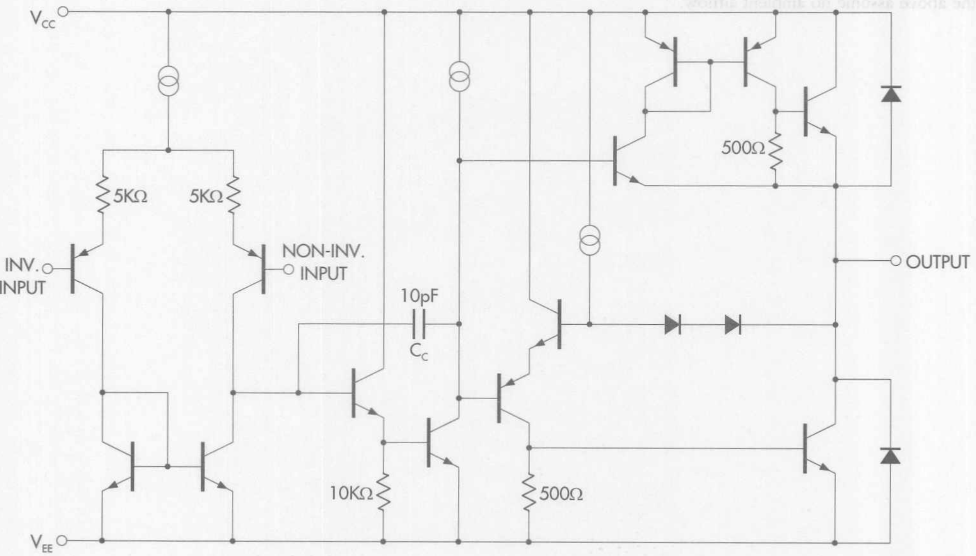
Available in a 5-pin TO-220 package, the SG2273/3273 provides system designers with a low-cost, convenient way to minimize power dissipation and reduce board area consumption in applications requiring high-current inductive load capability.

KEY FEATURES

- FULL OUTPUT SWING AT ±1A
- HIGH INDUCTIVE LOAD DRIVE CAPABILITY
- INTERNAL FLYBACK PROTECTION DIODES
- LOW POWER DISSIPATION
- SINGLE OR SPLIT SUPPLY OPERATION
- COMMON-MODE RANGE INCLUDES GROUND (V_{EE})
- HIGH OPEN LOOP GAIN
- LOW INPUT OFFSET VOLTAGE
- LARGE DIFFERENTIAL INPUT VOLTAGE RANGE
- THERMAL SHUTDOWN PROTECTION

PRODUCT HIGHLIGHT

SG2273 CIRCUIT SCHEMATIC DIAGRAM



PACKAGE ORDER INFO

T_A (°C)	P Plastic TO-220 5-pin
0 to 70	SG3273P
-45 to 85	SG2273P

FOR FURTHER INFORMATION CALL (714) 898-8121

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SG2273/SG3373

POWER OPERATIONAL AMPLIFIER

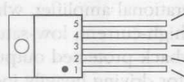
PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage (Single Supply) (V_{CC}) .... -0.3V to 14V
DC Output Current (I_{OUT}) .... ±1.4A
Peak Output Current (Non-Repetitive) (I_{OUT}) .... ±1.5A
Common-Mode Input Voltage (V_{ICM}) .... -0.3V to V_{CC}-2V
Differential-Mode Input Voltage (V_{IDM}) .... ±V_{CC}
Operating Junction Temperature
Plastic (P - Package) .... 150°C
Storage Temperature Range .... -65°C to 150°C
Lead Temperature (Soldering, 10 seconds) .... 300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

PACKAGE PIN OUTS



P PACKAGE
(Top View)

THERMAL DATA

P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	4.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	55°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The θ_{JA} numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

LINFINITY MICROELECTRONICS

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions			Units
		Min.	Typ.	Max.	
Supply Voltage (Single Supply)	V_{CC}	4.5		13.2	V
DC Output Current	I_{OUT}		±1.2		A
Common-Mode Input Voltage	V_{ICM}	0		V_{CC}-2	V
Differential-Mode Input Voltage	V_{IDM}		$\pm V_{CC}$		V
Operating Ambient Temperature Range:					
SG2273	T_A	-40		85	°C
SG3273	T_A	0		70	°C

Note 2. Range over which the device is guaranteed functional.

ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of -40°C ≤ T_A ≤ 85°C for the SG2373 and 0°C ≤ T_A ≤ 70°C for the SG3273; V_{CC}=12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG2273			SG3273			Units
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Static Characteristics									
Input Offset Voltage	V_{IO}	T_A = 25°C	-15	0	15	-15	0	15	mV
			-40		40	-30		30	mV
Input Bias Current	I_B	T_A = 25°C	-1.0	-0.2		-1.0	-0.2		µA
Input Offset Current	I_{OS}	T_A = 25°C	-50		50	-50		50	nA
			-200		200	-200		200	nA
Differential Input Resistance	R_{ID}		500			500			KΩ
Source Side Output Saturation Voltage	$+V_{SAT}$	I_{OUT} = 100mA		0.8	1.0		0.8		V
		I_{OUT} = 500mA		1.0	1.5		1.0	1.5	V
		I_{OUT} = 1A		1.4	2.0		1.4	2.0	V
Sink Side Output Saturation Voltage	$-V_{SAT}$	I_{OUT} = 100mA		0.3	0.7		0.3		V
		I_{OUT} = 500mA		0.6	1.0		0.6	1.0	V
		I_{OUT} = 1A		1.3	2.0		1.3	2.0	V
Open Loop Voltage Gain	A_{VOL}		70	90		70	90		dB
Common-Mode Rejection Ratio	CMRR	T_A = 25°C	66	90		66	90		dB
Power Supply Rejection Ratio	PSRR		60	80		60	80		dB
Quiescent Drain Current	I_{CC}	T_A = 25°C		7	17		7	15	mA
Thermal Shutdown Temperature		T_A = 25°C		175			175		°C
Dynamic Characteristics (T_A = 25°C)									
Gain Bandwidth Product	GBWP	RL = ∞Ω		800			800		KHz
Slew Rate	dV_O / dt	AV = 1		1.6			1.6		V/µs
Power Bandwidth, -3dB	PBW			200			200		KHz
Input Noise Voltage	E_N	22Hz to 22KHz		10			10		µV
Input Noise Current	I_N	22Hz to 22KHz		200			200		pA
Channel Separation	CS	f = 1KHz, R_L = 10Ω, AV_{CL} = 30dB		60			60		dB

SG2273/SG3373

POWER OPERATIONAL AMPLIFIER

PRODUCTION DATA SHEET

GRAPH / CURVE INDEX

Characteristic Curves

FIGURE INDEX

Application Circuits

LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 1. — LARGE SIGNAL TRANSIENT RESPONSE

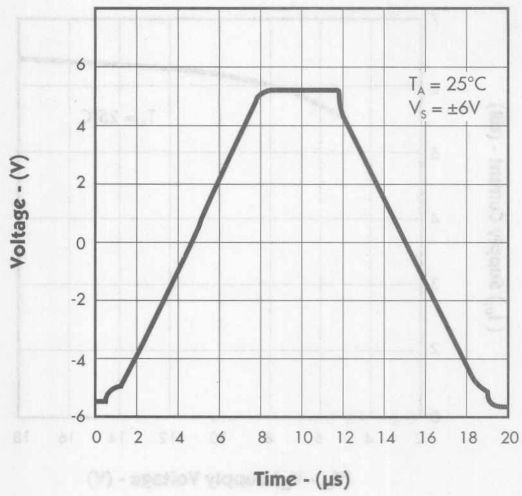


FIGURE 2. — SMALL SIGNAL TRANSIENT RESPONSE

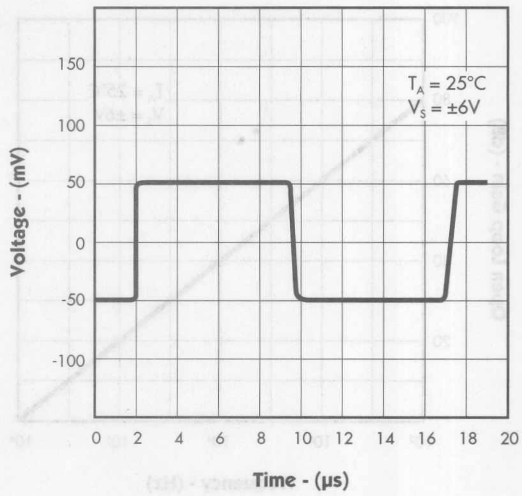


FIGURE 3. — COMMON-MODE REJECTION RATIO vs. FREQUENCY

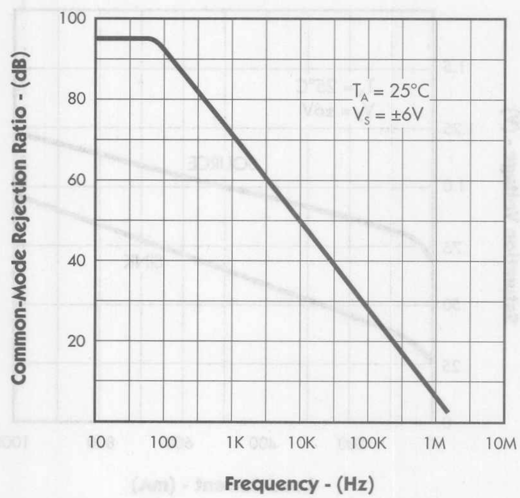
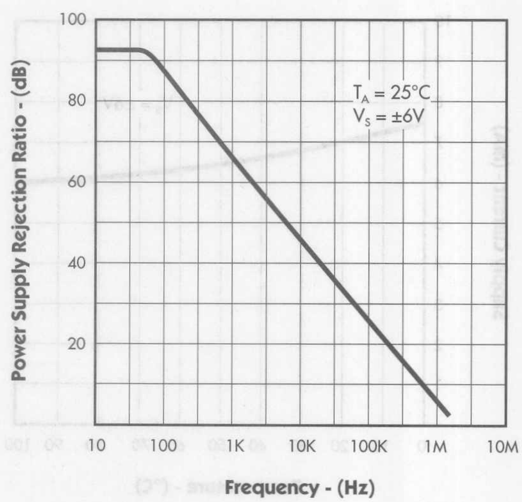


FIGURE 4. — POWER SUPPLY REJECTION vs. FREQUENCY



LINFINITY MICROELECTRONICS

CHARACTERISTIC CURVES

FIGURE 5. — OPEN LOOP GAIN vs. FREQUENCY

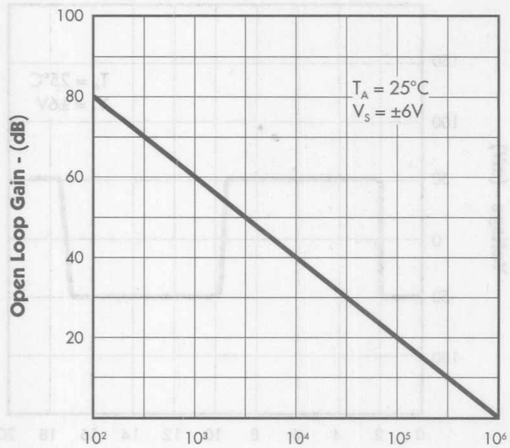


FIGURE 6. — SUPPLY CURRENT vs. SUPPLY VOLTAGE

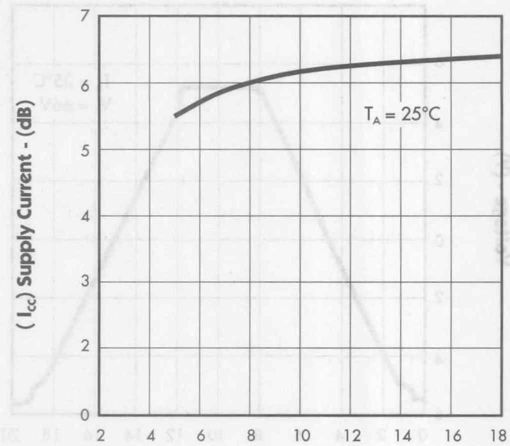


FIGURE 7. — SUPPLY CURRENT vs. TEMPERATURE

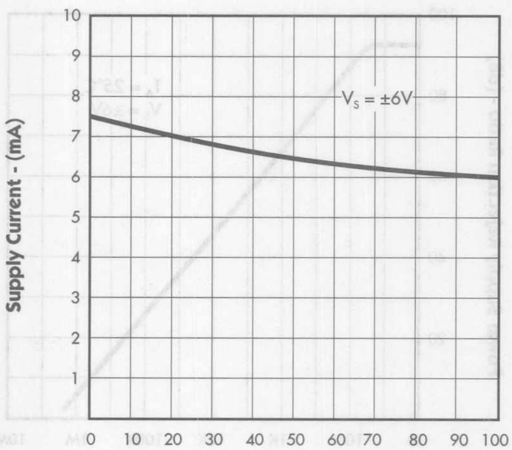
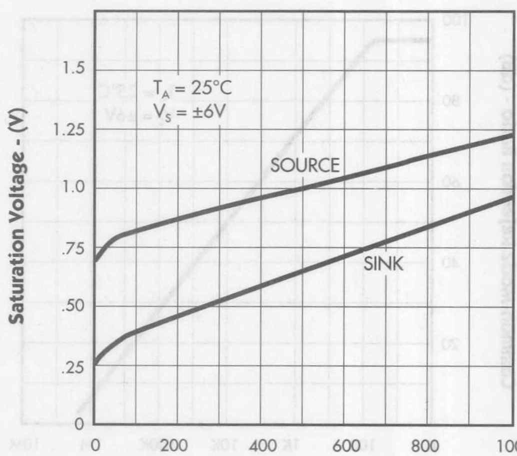


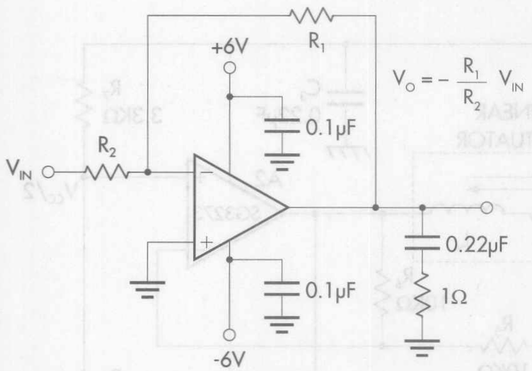
FIGURE 8. — SATURATION VOLTAGE vs. LOAD CURRENT



LINFINITY
MICROELECTRONICS

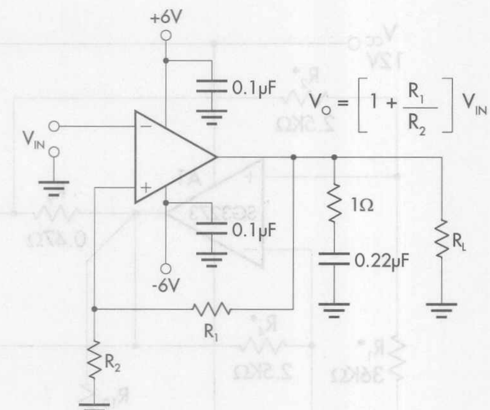
TYPICAL APPLICATION CIRCUITS

FIGURE 9. — INVERTING POWER AMPLIFIER



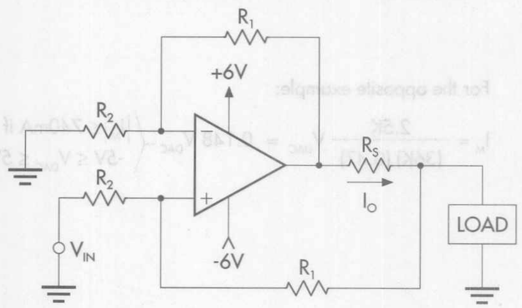
$$V_O = -\frac{R_1}{R_2} V_{IN}$$

FIGURE 10. — NON-INVERTING POWER AMPLIFIER



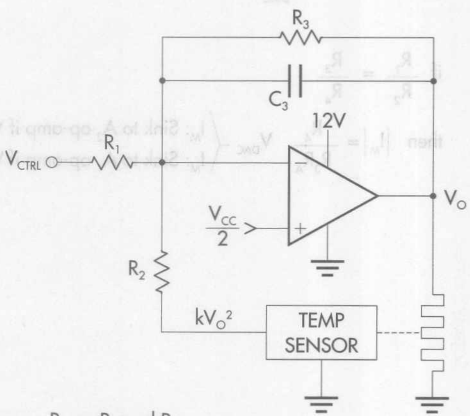
$$V_O = \left[1 + \frac{R_1}{R_2}\right] V_{IN}$$

FIGURE 11. — REGULATED CURRENT SOURCE FOR A GROUNDED LOAD



$$I_O = \frac{R_1}{R_2 \cdot R_S} V_{IN} \qquad R_S << R_1 \text{ and } R_2$$

FIGURE 12. — ADJUSTABLE TEMPERATURE CONTROL

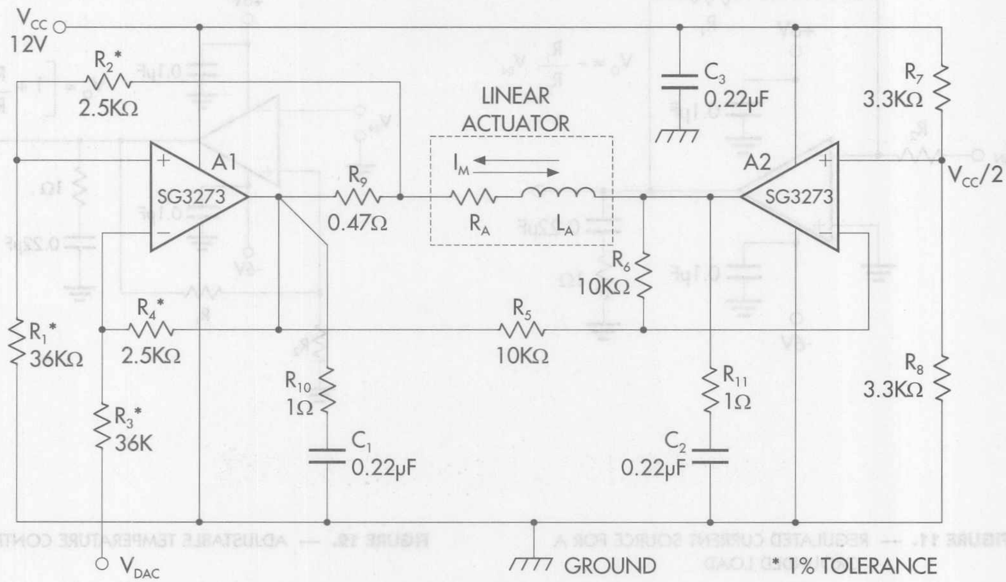


$R_3 >> R_1$ and R_2

$$V_O = \sqrt{\frac{1}{k}\left[\frac{V_{CC}}{2}\left(1 + \frac{R_1}{R_2}\right) - \frac{R_2}{R_1} V_{CTRL}\right]}$$

TYPICAL APPLICATION CIRCUITS

FIGURE 13. — 3.5-INCH WINCHESTER DISK DRIVE HEAD POSITION CONTROL AMPLIFIER



if $\frac{R_1}{R_2} = \frac{R_3}{R_4}$

then $|I_M| = \frac{R_4}{R_3 R_A} V_{DAC} \left\langle \begin{array}{l} I_M\text{: Sink to } A_2 \text{ op-amp if } V_{DAC} < 0 \\ I_M\text{: Sink to } A_1 \text{ op-amp if } V_{DAC} > 0 \end{array} \right.$

For the opposite example:

$I_M = \frac{2.5K}{(36K)\,(0.47)} V_{DAC} = 0.148\, V_{DAC} \left\langle \begin{array}{l} |I_M| \leq 740\text{mA if} \\ -5V \leq V_{DAC} \leq 5V \end{array} \right.$

LINFINITY MICROELECTRONICS

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG3272

DUAL-POWER OPERATIONAL AMPLIFIER

PRODUCTION DATA SHEET

DESCRIPTION

The SG3272 is a monolithic dual-power operational amplifier which features a high current, low saturation voltage, flyback protected output stage optimized for driving heavy inductive loads. Capable of operation in a single supply mode from as low as 4.5V up to 13.2V, the SG3272 is ideally suited for the computer peripheral environment, driving small motors, solenoids, and linear actuators in an H-bridge configuration.

As a general-purpose op-amp, the SG3272 exhibits low input offset voltage, high open loop gain, low quiescent current, a loarge differential input voltage range, and a common-mode input voltage range which includes ground (V_{EE}).

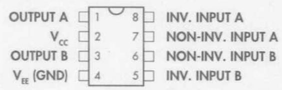
Available in either an 8-pin plastic dip package or a wide-body 20-pin SOIC Power, the SG3272 provides system designers with a low-cost, convenient way to minize power dissipation and reduce board area comsumption in applications requiring high current inductive load drive capability.

KEY FEATURES

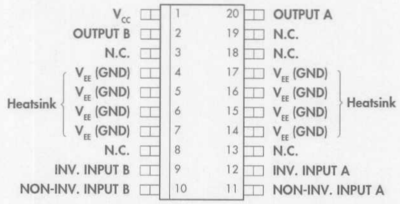
- FULL OUTPUT SWING AT ±500mA
- HIGH INDUCTIVE LOAD DRIVE CAPABILITY
- INTERNAL FLYBACK PROTECTION DIODES
- LOW POWER DISSIPATION
- SINGLE OR SPLIT SUPPLY OPERATION
- COMMON-MODE RANGE INCLUDES GROUND (V_{EE})
- HIGH OPEN LOOP GAIN
- LOW INPUT OFFSET VOLTAGE
- LARGE DIFFERENTIAL INPUT VOLTAGE RANGE
- THERMAL SHUTDOWN PROTECTION

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



DWP PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	M Ceramic DIP 8-pin	DWP Plastic SOWB Power, 16-pin
0 to 70	SG3272M	SG3272DWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3272DWPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG3645

QUAD 2.5 AMP POWER DRIVER

NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

DESCRIPTION

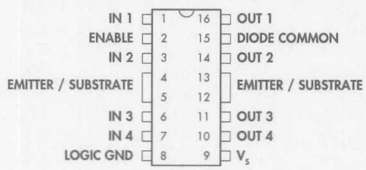
The SG3645 is a quad high voltage, high current driver ideal for driving stepper motors. Each channel consists of TTL compatible inputs and open collector-Darlington outputs with integral transient suppression diodes. A common enable is provided to diable or enable all four outputs simultaneously. The output stages are capable of sinking 2.5 Amps with breakdown voltage in excess of 60 volts. Thermal shutdown is provided to disable the outputs if excessive die heating occurs. The SG3645 is specified for operation over the ambient temperature range of 0°C to 125°C and is available in the thermally efficient plastic Batwing package.

KEY FEATURES

- PEAK OUTPUT CURRENTS TO 3.5A
- OUTPUT VOLTAGES TO 60V
- INTEGRAL CLAMP DIODES
- COMMON ENABLE PIN
- TTL COMPATIBLE INPUTS
- THERMAL SHUTDOWN PROTECTION

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



W PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	W Plastic Batwing 16-pin
0 to 125	SG3645W

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Notes

Thumb Index

LINFINITY
MICROELECTRONICS

Notes

Section Index

OTHER LINEAR CIRCUITS

Interface Circuits

Transistor Arrays

Sense Amplifiers

Diode Arrays

Bold = New Product, ****Bold Italic**** = Preliminary

LINFINITY MICROELECTRONICS

Selection Guide

Other Linear Circuits

Interface Circuits

Device Type	Description	Key Features	Characteristics	Packages
SG2000 Series SG2001 thru SG2024	DARLINGTON ARRAYS. Page # 10-9	1. Seven open collector Darlington arrays. 2. Internal clamp diodes. 3. High-speed switching. 4. Closely matched parameters.	$I_{O(PK)}$: N/A $I_{O(CONT)}$: 0.5A $V_{C(MAX)}$: 50V, 95V*	J, N, L
SG2800 Series SG2801 thru SG2824	DARLINGTON ARRAYS. Page # 10-11	1. Eight open collector Darlington arrays. 2. Internal clamp diodes. 3. High-speed switching. 4. Closely matched parameters.	$I_{O(PK)}$: N/A $I_{O(CONT)}$: 0.5A $V_{C(MAX)}$: 50V, 95V*	J, N, L
SG55325 SG75325	DUAL SOURCE / DUAL SINK MEMORY DRIVER. Page # 10-19	1. 2 open emitter, 2 open collector output stages. 2. Output clamp circuitry on sink transistors. 3. Source base drive externally adjustable. 4. Fast switching time. 5. TTL or DTL compatibility. 6. MIL-M-38510 / 13001BEA QPL JAN55325J	$I_{O(PK)}$: 0.75A $I_{O(CONT)}$: 0.6A $V_{C(MAX)}$: 24V $V_{CC(MAX)}$: 7V & 24V	J, N, F, L
SG55326 SG75326	QUAD SINK MEMORY DRIVER. Page # 10-21	1. 4 open collector output stages. 2. Output clamp circuitry on all outputs. 3. Output transistor base drives externally adjustable. 4. Fast switching time. 5. TTL or DTL compatibility. 6. MIL-M-38510 / 13001BEA QPL JAN55325J	$I_{O(PK)}$: 0.75A $I_{O(CONT)}$: 0.6A $V_{C(MAX)}$: 24V $V_{CC(MAX)}$: N/A	J, N, F
SG55327 SG75327	QUAD SOURCE MEMORY DRIVER. Page # 10-23	1. 4 open emitter output stages. 2. Can operate as a sink driver. 3. Output transistor base drives externally adjustable. 4. Fast switching time. 5. TTL or DTL compatibility.	$I_{O(PK)}$: 0.75A $I_{O(CONT)}$: 0.6A $V_{C(MAX)}$: 24V $V_{CC(MAX)}$: 7V & 24V	J, N, F

* SG2021 thru SG2024 only.

* SG2821 thru SG2824 only.

Interface Circuits

Device Type	Description	Key Features	Characteristics	Packages
SG55450B/75450B SG55460/75460 SG55470/75470	**DUAL PERIPHERAL POSITIVE AND DRIVER.** PAGE # 10-25	1. Two NAND gates and two uncommitted NPN transistors. 2. High-speed switching. 3. TTL or DTL compatible diode-clamped inputs. 4. Can be configured as an AND gate (common emitter configuration) or as a NAND gate (emitter follower configuration)	$I_{O(PK)}$ 0.4A $I_{O(CONT)}$ 0.3A $V_{C(MAX)}$ ** $V_{CC(MAX)}$ 7V	J, L
SG55451B/75451B SG55461/75461 SG55471/75471	**DUAL PERIPHERAL POSITIVE AND DRIVER.** PAGE # 10-27	1. Two AND gates with open collector outputs. 2. High-speed switching. 3. TTL or DTL compatible diode-clamped inputs.	$I_{O(PK)}$ 0.4A $I_{O(CONT)}$ 0.3A $V_{C(MAX)}$ ** $V_{CC(MAX)}$ 7V	Y, L
SG55452B/75452B SG55462/75462 SG55472/75472	**DUAL PERIPHERAL NAND DRIVER.** PAGE # 10-29	1. Two NAND gates with open collector outputs. 2. High-speed switching. 3. TTL or DTL compatible diode-clamped inputs.	$I_{O(PK)}$ 0.4A $I_{O(CONT)}$ 0.3A $V_{C(MAX)}$ ** $V_{CC(MAX)}$ 7V	Y, L
SG55453B/75453B SG55463/75463 SG55473/75473	**DUAL PERIPHERAL OR DRIVER.** PAGE # 10-31	1. Two OR gates with open collector outputs. 2. High-speed switching. 3. TTL or DTL compatible diode-clamped inputs.	$I_{O(PK)}$ 0.4A $I_{O(CONT)}$ 0.3A $V_{C(MAX)}$ ** $V_{CC(MAX)}$ 7V	Y, L
SG55454B/75454B SG55464/75464 SG55474/75474	**DUAL PERIPHERAL NOR DRIVER.** PAGE # 10-33	1. Two NOR gates with open collector outputs. 2. High-speed switching. 3. TTL or DTL compatible diode-clamped inputs.	$I_{O(PK)}$ 0.4A $I_{O(CONT)}$ 0.3A $V_{C(MAX)}$ ** $V_{CC(MAX)}$ 7V	Y, L

** *SG55450B = **35V**, SG55460 = **40V**, and SG55470 = **70V**.*

** *SG55451B = **30V**, SG55461 = **35V**, and SG55471 = **70V**.*

** *SG55452B = **30V**, SG55462 = **35V**, and SG55472 = **70V**.*

** *SG55453B = **30V**, SG55463 = **35V**, and SG55473 = **70V**.*

** *SG55454B = **30V**, SG55464 = **35V**, and SG55474 = **70V**.*

Selection Guide

OTHER LINEAR CIRCUITS

Transistor Arrays

DEVICE TYPE	DESCRIPTION	KEY FEATURES	CHARACTERISTICS	PACKAGES
SG3081	TRANSISTOR ARRAYS. PAGE # 10-13	1. 7 transistors with all emitters common. 2. Base & collectors are uncommitted. 3. Uncommitted substrate. 4. Avail. as SMD only. (5962-8866401E(X))	$I_{O (PK)}$ 100mA $I_{O (CONT)}$ 80mA $V_{C (MAX)}$ 16V $V_{CC (MAX)}$ N/A	J

Sense Amplifiers

DEVICE TYPE	DESCRIPTION	KEY FEATURES	PACKAGES
SG55236	DUAL SENSE AMPLIFIER / DATA REGISTERS PAGE # 10-17	1. Threshold voltage matching (ΔV_{TH}): 1.5mV 2. Adjustable differential-input threshold voltage. 3. Reference amplifier inherently stable with no external frequency compensation required. 4. Built-in data buffer driver 450pF load in 15ns. 5. Internal reference voltage attenuator makes reference amplifier less sensitive to noise.	F

LINFINITY MICROELECTRONICS

Selection Guide

OTHER LINEAR CIRCUITS

Diode Arrays

DEVICE TYPE	DESCRIPTION	PAGE #	KEY FEATURES	CHARACTERISTICS	PACKAGES
SG6100 SG6511	7 STRAIGHT THRU DIODES.	10-37	1. 75V minimum breakdown voltage. 2. 100mA current capability per diode. 3. Switching speeds less than 5ns. 4. Low leakage current < 25nA. 5. JANTXV, JANTX & JAN processing available.	$V_{BR\,(MIN)}$ 75V; $i_{R\,(MAX)}$ 25nA; $t_{rr\,(MAX)}$ 5ns	F*, J*
SG6101 SG6510	8 STRAIGHT THRU DIODES.	10-37	1. 75V minimum breakdown voltage. 2. 100mA current capability per diode. 3. Switching speeds less than 5ns. 4. Low leakage current < 25nA. 5. JANTXV, JANTX & JAN processing available.	$V_{BR\,(MIN)}$ 75V; $i_{R\,(MAX)}$ 25nA; $t_{rr\,(MAX)}$ 5ns	F*, J*
SG5768 SG6506	8 COMMON CATHODE DIODE ARRAY.	10-35	1. 60V minimum breakdown voltage. 2. 500mA current capability per diode. 3. Maximum reverse recovery time (t_{rr}) of 20ns. 4. Maximum forward recovery time (t_{fr}) of 40ns. 5. Reverse current (i_r) < 100nA. 6. JANTXV, JANTX & JAN processing available.	$V_{BR\,(MIN)}$ 60V; $i_{R\,(MAX)}$ 100nA; $t_{rr\,(MAX)}$ 20ns	F*, J*
SG5770 SG6507	8 COMMON ANODE DIODE ARRAY.	10-35	1. 60V minimum breakdown voltage. 2. 500mA current capability per diode. 3. Maximum reverse recovery time (t_{rr}) of 20ns. 4. Maximum forward recovery time (t_{fr}) of 40ns. 5. Reverse current (i_r) < 100nA. 6. JANTXV, JANTX & JAN processing available.	$V_{BR\,(MIN)}$ 60V; $i_{R\,(MAX)}$ 100nA; $t_{rr\,(MAX)}$ 20ns	F*, J*
SG5772 SG6508	16 DIODE ARRAY.	10-35	1. 60V minimum breakdown voltage. 2. 500mA current capability per diode. 3. Maximum reverse recovery time (t_{rr}) of 20ns. 4. Maximum forward recovery time (t_{fr}) of 40ns. 5. Reverse current (i_r) < 100nA. 6. JANTXV, JANTX & JAN processing available.	$V_{BR\,(MIN)}$ 60V; $i_{R\,(MAX)}$ 100nA; $t_{rr\,(MAX)}$ 20ns	F*, J*

* "F" package applies only to the SG6100; "J" package applies only to the SG6511.

* "J" package applies only to the SG6101; "F" package applies only to the SG6510.

* "F" package applies only to the SG5768; "J" package applies only to the SG6506.

* "F" package applies only to the SG5770; "J" package applies only to the SG6507.

* "F" package applies only to the SG5772; "J" package applies only to the SG6508.

Selection Guide

OTHER LINEAR CIRCUITS

Diode Arrays

DEVICE TYPE	DESCRIPTION	KEY FEATURES	CHARACTERISTICS	PACKAGES
SG5774 SG6509	**4 COMMON ANODE, 4 COMMON CATHODE DIODE ARRAY.** PAGE # 10-35	1. 60V minimum breakdown voltage. 2. 500mA current capability per diode. 3. Maximum reverse recovery time (t_{rr}) of 20ns. 4. Maximum forward recovery time (t_{fr}) of 40ns. 5. Reverse current (i_r) < 100nA. 6. JANTXV, JANTX & JAN processing available.	$V_{BR\ (MIN)}$ 60V $i_{R\ (MAX)}$ 100nA $t_{rr\ (MAX)}$ 20ns	F* J*

* "F" package applies only to the SG5774; "J" package applies only to the SG6509.

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG2000 Series

HIGH VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

PRODUCTION DATA SHEET

DESCRIPTION

The SG2000 series integrates seven NPN Darlington pairs with internal suppression diodes to drive lamps, relays, and solenoids in many military, aerospace, and industrial applications that require severe environments. All units feature open collector outputs with greater than 50V breakdown voltages combined with 500mA current carrying capabilities. Five different input configurations provide optimized designs for interfacing with DTL, TTL, PMOS, or CMOS drive signals. These devices are designed to operate from -55°C to 125°C ambient temperature in a 16-pin dual in line ceramic (J) package and 20-pin Leadless Chip Carrier (LCC). The plastic dual in-line (N) is designed to operate over the commercial temperature range of 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

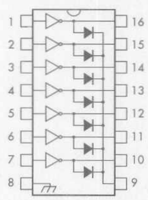
KEY FEATURES

- SEVEN NPN DARLINGTON PAIRS
- -55°C TO 125°C AMBIENT OPERATING TEMPERATURE RANGE
- COLLECTOR CURRENTS TO 600mA
- OUTPUT VOLTAGES FROM 50V TO 95V
- INTERNAL CLAMPING DIODES FOR INDUCTIVE LOADS
- DTL, TTL, PMOS, OR CMOS COMPATIBLE INPUTS
- HERMETIC CERAMIC PACKAGE

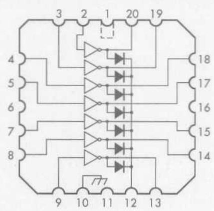
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/14101BEA - JAN2001J
- MIL-M38510/14102BEA - JAN2002J
- MIL-M38510/14103BEA - JAN2003J
- MIL-M38510/14104BEA - JAN2004J
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic Dip 16-pin	J Ceramic Dip 16-pin	L Ceramic LCC 20-pin
0 to 70	SG2003N	—	—
	SG2023N	—	—
-55 to 125	—	SG20xxJ	SG20xxL
MIL-STD-883	—	SG20xxJ/883B	SG20xxL/883B
DESC	—	SG20xxJ/DESC	—
JAN	—	JAN2001J	—
	—	JAN2002J	—
	—	JAN2003J	—
	—	JAN2004J	—

"xx" is determined by selection guide, see next page.

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SG2000 Series

HIGH-VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

PRODUCTION DATA SHEET

SELECTION GUIDE

Device	V_{CE} Max	I_C Max	Logic Inputs
SG2001	50V	500mA	General Purpose PMOS, CMOS
SG2002	50V	500mA	14V-25V PMOS
SG2003	50V	500mA	5V TTL, CMOS
SG2004	50V	500mA	6V-15V CMOS, PMOS
SG2011	50V	600mA	General Purpose PMOS, CMOS
SG2012	50V	600mA	14V-25V PMOS
SG2013	50V	600mA	5V TTL, CMOS
SG2014	50V	600mA	6V-15V CMOS, PMOS
SG2015	50V	600mA	High Output TTL
SG2021	95V	500mA	General Purpose PMOS, CMOS
SG2023	95V	500mA	5V TTL, CMOS
SG2024	95V	500mA	6V-15V CMOS, PMOS

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THE INFINITE POWER OF INNOVATION

SG2800 Series

HIGH VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

PRODUCTION DATA SHEET

DESCRIPTION

The SG2800 series integrates eight NPN Darlington pairs with internal suppression diodes to drive lamps, relays, and solenoids in many military, aerospace, and industrial applications that require severe environments. All units feature open collector outputs with greater than 50V breakdown voltages combined with 500mA current carrying capabilities. Five different input configurations provide optimized designs for interfacing with DTL, TTL, PMOS, or CMOS drive signals. These devices are designed to operate from -55°C to 125°C ambient temperature in an 18-pin dual in line ceramic (J) package and 20-pin Leadless Chip Carrier (LCC).

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

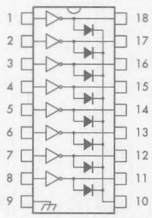
KEY FEATURES

- EIGHT NPN DARLINGTON PAIRS
- COLLECTOR CURRENTS TO 600mA
- OUTPUT VOLTAGES FROM 50V TO 95V
- INTERNAL CLAMPING DIODES FOR INDUCTIVE LOADS
- DTL, TTL, PMOS, OR CMOS COMPATIBLE INPUTS
- HERMETIC CERAMIC PACKAGE

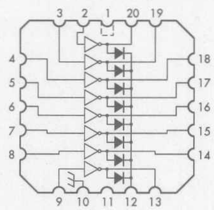
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/14106BVA - JAN2801J
- MIL-M38510/14107BVA - JAN2802J
- MIL-M38510/14108BVA - JAN2803J
- MIL-M38510/14109BVA - JAN2804J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin
-55 to 125	SG2803N	SG28xxJ	SG28xxL
	SG2823N	—	—
MIL-STD-883	—	SG28xxJ/883B	SG28xxL/883B
DESC	—	SG2803J/DESC	SG2803L/DESC
	—	SG2821J/DESC	SG2821L/DESC
	—	SG2823J/DESC	SG2823L/DESC
	—	SG2824J/DESC	SG2824L/DESC
JAN	—	JAN2801J	—
	—	JAN2802J	—
	—	JAN2803J	—
	—	JAN2804J	—

"xx" is determined by selection guide, see next page.

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SELECTION GUIDE

Device	V_{CE} Max	I_C Max	Logic Inputs
SG2801	50V	500mA	General Purpose PMOS, CMOS
SG2802	50V	500mA	14V-25V PMOS
SG2803	50V	500mA	5V TTL, CMOS
SG2804	50V	500mA	6V-15V CMOS, PMOS
SG2811	50V	600mA	General Purpose PMOS, CMOS
SG2812	50V	600mA	14V-25V PMOS
SG2813	50V	600mA	5V TTL, CMOS
SG2814	50V	600mA	6V-15V CMOS, PMOS
SG2815	50V	600mA	High Output TTL
SG2821	95V	500mA	General Purpose PMOS, CMOS
SG2823	95V	500mA	5V TTL, CMOS
SG2024	95V	500mA	6V-15V CMOS, PMOS

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SG3081

TRANSISTOR ARRAY

PRODUCTION DATA SHEET

DESCRIPTION

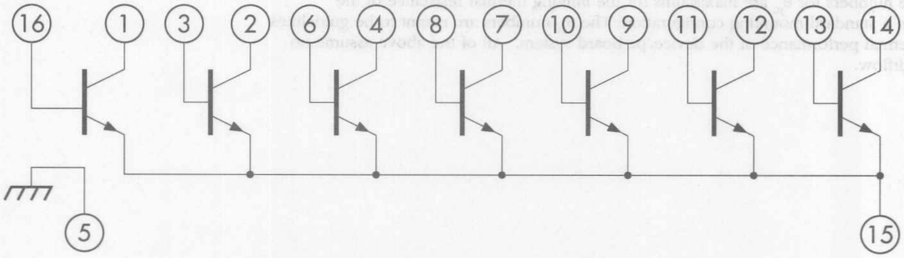
The SG3081 has seven high-current silicon NPN transistors integrated into a single monolighic chip and has all seven emitters common. The device has a separate substrate pin for more versatile applications. With current capability to 100mA per transistor, this array is ideally suited for driving all types of seven-segment displays as well as other general purpose driver applications.

KEY FEATURES

- COLLECTOR CURRENT TO 100mA
- LOW SATURATION VOLTAGE
- CLOSELY MATCHED PARAMETERS

PRODUCT HIGHLIGHT

SG3081 SCHEMATIC DIAGRAM



PACKAGE ORDER INFO

T_A (°C)	J Ceramic DIP 16-pin
-55 to 125	SG3081J
MIL-STD-883B	SG3081J/993B
DESC	SG3081J/DESC

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SG3081

TRANSISTOR ARRAY

PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATINGS (Note 1)

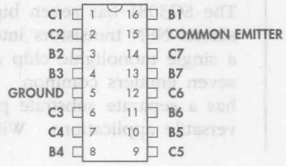
Power Dissipation:
- Any One Transistor 0.5A
- Total Package 2.0A

Operating Junction Temperature:
- Hermetic (J, L Package) .... 150°C

Storage Temperature Range .... 65°C to 150°C
Lead Temperature (soldering, 10 seconds) .... 300°C

Note 1. Exceeding these ratings could cause damage to the device.

PACKAGE PIN OUTS



J PACKAGE
(Top View)

THERMAL DATA

J PACKAGE:

THERMAL RESISTANCE-JUNCTION TO CASE, θ_{JC}	30°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ_{JA}	80°C/W

Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$.
The above numbers for θ_{JC} are maximums for the limiting thermal resistance of the package in a standard mounting configuration. The θ_{JA} numbers are meant to be guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

LINFINITY MICROELECTRONICS

TRANSISTOR ARRAY

PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol	Recommended Operating Conditions Min.	Typ.	Max.	Units
Collector to Emitter Voltage	V_{CEO}		16		V
Collector to Base Voltage	V_{CBO}		20		V
Collector to Substrate Voltage	V_{CSO}		20		V
Emitter to Base Voltage	V_{EBO}		5		V
Collector Current	I_C		100		mA
Base Current	I_B		20		mA
Operating Ambient Temperature Range:					
SG3081		-55		125	°C

Note 2. Range over which the device is functional.

ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperature. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG3081 Min.	Typ.	Max.	Units
Collector-Base Breakdown Voltage	BV_{CBO}	$I_C = 500\mu A$, $I_E = 0$	5.05	5.10	5.15	V
Collector-Substrate Breakdown Voltage	BV_{CSO}	$I_{CI} = 500\mu A$, $I_E = 0$, $I_B = 0$		0.2	5	mV
Collector-Emitter Breakdown Voltage	BV_{CEO}	$I_C = 500\mu A$, $I_B = 0$		3	15	mV
Emitter-Base Breakdown Voltage	BV_{EBO}	$I_C = 500\mu A$			0.4	mV/°C
DC Forward-Current Transfer Ratio	h_{FE}	$V_{CE} = 5.0V$, $I_C = 30mA$	5.00		5.20	V
		$T_A = 25°C$		50		μV_{RMS}
		$V_{CE} = 5.0V$, $I_C = 50mA$		5	25	mV
		$T_A = 25°C$	-15	-50	-100	mA
Base-Emitter Saturation Voltage	V_{BEsat}	$I_C = 30mA$, $I_B = 1mA$				
		$T_A = 25°C$				
Collector-Emitter Saturation Voltage	V_{CEsat}	$I_C = 30mA$, $I_B = 1mA$				
		$I_C = 30mA$, $I_B = 1mA$, $T_A = 25°C$				
		$I_C = 50mA$, $I_B = 5mA$				
		$T_A = 25°C$				
Collector-Cutoff-Current	I_{CEO}	$V_{CE} = 10V$, $I_B = 0$				
		$T_A = 25°C$				
Collector-Cutoff Current	I_{CBO}	$V_{CB} = 10V$, $I_E = 0$				
		$T_A = 25°C$				

Notes

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SG55236

DUAL SENSE AMPLIFIER/DATA REGISTERS

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55236 is a monolithic, dual channel, high-speed sense amplifier with independently-controlled data registers. The input section features an adjustable differential-input threshold voltage. All four inputs of the sense amplifier have been screened to guarantee threshold matching (see Δ_{TH} in electrical characteristics).

Separate detector outputs for each channel allow the designer the flexibility to use additional output stages if necessary. In addition, each of the data registers has provisions for external data inputs. The SG55236 is available in a 24-pin flat pack and is characterized over the full military ambient temperature range of -55°C to 125°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

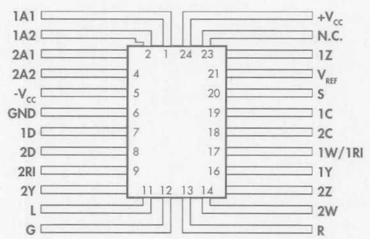
KEY FEATURES

- THRESHOLD VOLTAGE MATCHING (ΔV_{TH}):
  SG55236 1.5mV
- ADJUSTABLE DIFFERENTIAL-INPUT THRESHOLD VOLTAGE
- REFERENCE AMPLIFIER INHERENTLY STABLE WITH NO EXTERNAL FREQUENCY COMPENSATION REQUIRED
- BUILT-IN DATA REGISTER WITH PROVISIONS FOR EXTERNAL DATA INPUTS
- BUILT-IN DATA BUFFER DRIVES 450pF LOAD IN 15ns
- INTERNAL REFERENCE VOLTAGE ATTENUATOR MAKES REFERENCE AMPLIFIER LESS SENSITIVE TO NOISE

HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



F PACKAGE
(Top View)

PACKAGE ORDER INFO

T_A (°C)	F Ceramic Flat Pack 24-pin
-55 to 125	SG55236F
MIL-STD-883	SG55236F/883B

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SG55325/SG75325

QUAD SOURCE/DUAL SINK MEMORY DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55325/75325 is a monolithic dual source/dual sink driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver can be independently selected through separate input logic. Also, each pair of drivers (sink of source pairs) has a separate strobe input to allow control of either pair of drivers. Each driver of the SG55325/75325 can switch 600mA.

Although used extensively in magnetic memory systems, this versatile driver has been used to drive relays, lamps, and small motors as well as being used as the driver in a clock circuit.

The SG55325 is characterized for use over the military ambient temperature range of -55° to 125°C. The SG75325 has an operating ambient temperature range of 0° to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

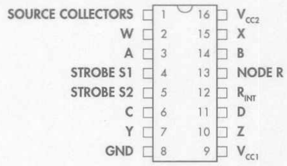
KEY FEATURES

- 600mA OUTPUT CAPABILITY
- FAST SWITCHING TIMES
- OUTPUT SHORT-CIRCUIT PROTECTION
- 24V OUTPUT CAPABILITY
- SOURCE BASE DRIVE EXTERNALLY ADJUSTABLE
- TTL OR DTL COMPATIBILITY
- INPUT CLAMPING DIODES

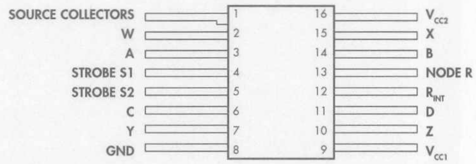
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M-38510/13001BEA - JAN55325J
- MIL-M-38510/13001BFA - JAN55325F
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

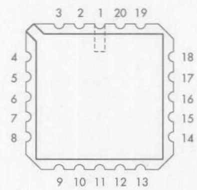
PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



F PACKAGE
(Top View)



1. N.C.
2. SOURCE COLLECTOR
3. W
4. A
5. STROBE S1
6. N.C.
7. STROBE S2
8. C
9. Y
10. GND
11. N.C.
12. V_{CC1}
13. Z
14. D
15. R_{INT}
16. N.C.
17. NODE R
18. B
19. X
20. V_{CC2}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin	L Ceramic LCC 20-pin
0 to 70	SG7532N	SG7532J	—	—
-55 to 125	—	SG55325J	SG55325F	—
MIL-STD-883	—	SG55325J/883B	SG55325F/883B	SG55325L/883B

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SG55326/SG75326

QUAD SINK MEMORY DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55326/SG75326 is a monolithic quad positive-OR sink driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver is independently controlled and capable of sinking up to 600mA.

Paired with the SG55327 Quad Source Driver, the SG55326/SG75326 provides the current drive necessary for many sink/source applications.

Although designed specifically for magnetic memory applications, the SG55326/SG75326 has been used to drive clock circuits, relays, lamps, and small motors, or any application where a 600mA sink driver is needed.

The SG55326 is characterized for use over the full military operating ambient temperature of -55° to 125°C while the SG75326 is characterized over the operating ambient temperature of 0° to 70°C.

These devices are available in 16-pin ceramic DIP, 16-pin plastic DIP and 16-pin flatpack.

KEY FEATURES

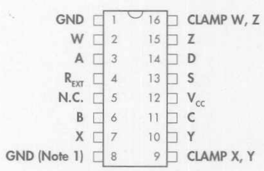
- 600mA OUTPUT CURRENT SINK CAPABILITY
- 24V OUTPUT CAPABILITY
- CLAMP VOLTAGE VARIABLE TO 24V
- HIGH-REPETITION-RATE DRIVER COMPATIBLE WITH HIGH-SPEED MAGNETIC MEMORIES
- INPUTS COMPATIBLE WITH TTL LEVEL DECODERS
- MINIMUM TIME SKEW BETWEEN STROBE AND OUTPUT CURRENT RISE
- PULSE-TRANSFORMER COUPLING ELIMINATED
- DRIVE-LINE LENGTHS REDUCED

HIGH RELIABILITY FEATURES

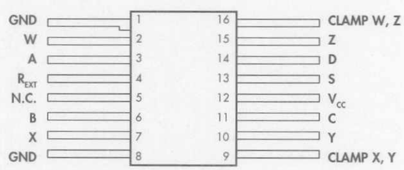
- AVAILABLE TO MIL-STD-883B
- MIL-M-38510/13001BEA - JAN55326J
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



F PACKAGE
(Top View)

Note 1: Pin 8 is in electrical contact with the metal base.

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin
0 to 70	SG75326N	SG75326J	—
-55 to 125	—	SG55326J	SG55326F
MIL-STD-883	—	SG55326J/883B	SG55326F/883B

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SG55327/SG75327

QUAD SOURCE MEMORY DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55327/SG75327 is a monolithic quad source driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver is independently controlled and capable of sinking up to 600mA.

Paired with the SG55326 Quad Sink Driver, the SG55327/SG75327 provides the current drive necessary for many sink/source applications.

The SG55327/SG75327 has also been used in many non-memory applications: for example, as the driver for a clock circuit, relay, lamp, or small motor, or any application where a 600mA source driver is needed.

The SG55327 is characterized for use over the full military operating ambient temperature range of -55° to 125°C while the SG75327 is characterized from 0° to 70°C.

KEY FEATURES

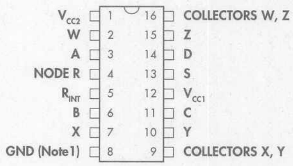
- QUAD SOURCE MEMORY DRIVERS
- 500mA OUTPUT CURRENT CAPABILITY
- V_{CC2} DRIVE VOLTAGE VARIABLE TO 24V
- OUTPUT CAPABLE OF SWINGING BETWEEN V_{CC2} AND GROUND
- HIGH-REPETITION-RATE DRIVER COMPATIBLE WITH HIGH-SPEED MAGNETIC MEMORIES
- INPUTS COMPATIBLE WITH TTL DECODERS
- MINIMUM TIME SKEW BETWEEN STROBE AND OUTPUT-CURRENT RISE
- PULSE-TRANSFORMER COUPLING ELIMINATED
- DRIVE-LINE LENGTHS REDUCED

HIGH RELIABILITY FEATURES

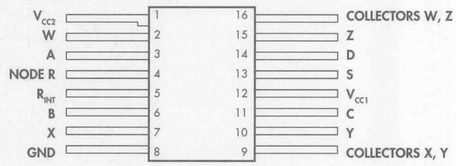
- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J & N PACKAGE
(Top View)



F PACKAGE
(Top View)

Note 1: Pin 8 is in electrical contact with the metal base.

PACKAGE ORDER INFORMATION

T_A (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin
0 to 70	SG75327N	SG75327J	—
-55 to 125	—	SG55327J	SG55327F
MIL-STD-883	—	SG55327J/883B	SG55327F/883B

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LINFINITY MICROELECTRONICS

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SG55450B/SG75450B Series

DUAL PERIPHERAL POSITIVE-AND DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55450B/SG55460/SG55470 (SG75450B/SG75460/SG75470) series of dual peripheral Positive-AND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55450B/60/70 (SN75450B/60/70) series. Diode-clamped inputs simplify circuit design. Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. These parts are unique general-purpose devices each featuring two standard Series 54/74 TTL gates and two uncommitted, high-current, high-voltage n-p-n transistors and offer the system designer the flexibility of tailoring the circuit to the application. The SG55450B/SG55460/SG55470 drivers are characterized for operation over the full military ambient temperature range of -55° to 125°C and the SG75450B/SG75460/SG75470 drivers are characterized for operation from 0° to 70°C.

KEY FEATURES

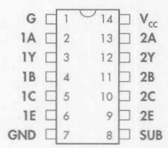
- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

HIGH RELIABILITY FEATURES

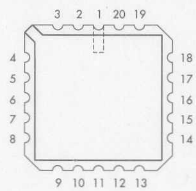
- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



J PACKAGE
(Top View)



1. N.C.	11. N.C.
2. G	12. SUB
3. 1A	13. 2E
4. 1Y	14. 2C
5. N.C.	15. N.C.
6. 1B	16. 2B
7. N.C.	17. N.C.
8. 1C	18. 2Y
9. 1E	19. 2A
10. GND	20. V_{cc}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	L Ceramic LCC 20-pin
0 to 70	SG75450BJ	—
	SG75460J	—
	SG75470J	—
-55 to 125	SG55450BJ	SG55450BL
	SG55460J	SG55460L
	SG55470J	SG55470L
MIL-STD-883	SG55450BJ/883B	SG55450BL/883B
	SG55460J/883B	SG55460L/883B
	SG55470J/883B	SG55470L/883B

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SG55451B/SG75451B Series

DUAL PERIPHERAL POSITIVE-AND DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55451B/SG55461/SG55471 (SG75451B/SG75461/SG75471) series of dual peripheral Positive-AND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55451B/61/71 (SN7451B/61/71) series. Diode-clamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, line drivers, and memory drivers. The SG55451B/SG55461/SG55471 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75451B/SG75461/SG75471 drivers are characterized for operation from 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

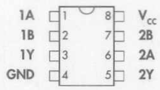
KEY FEATURES

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

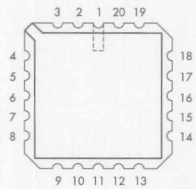
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



1. N.C.	11. N.C.
2. 1A	12. 2Y
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. 1B	15. 2A
6. N.C.	16. N.C.
7. 1Y	17. 2B
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. GND	20. V_{cc}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
0 to 70	SG75451BY	—
	SG75461Y	—
	SG75471Y	—
-55 to 125	SG55451BY	SG55451BL
	SG55461Y	SG55461L
	SG55471Y	SG55471L
MIL-STD-883	SG55451BY/883B	SG55451BL/883B
	SG55461Y/883B	SG55461L/883B
	SG55471Y/883B	SG55471L/883B

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SG55452B/SG75452B Series

DUAL PERIPHERAL POSITIVE-NAND DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55452B/SG55462/SG55472 (SG75452B/SG75462/SG75472) series of dual peripheral Positive-NAND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55452B/62/72 (SN75452B/62/72) series. Diode-clamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55452B/SG55462/SG55472 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75452B/SG75462/SG75472 drivers are characterized for operation from 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

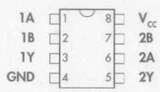
KEY FEATURES

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

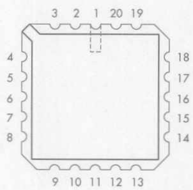
HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



1. N.C.	11. N.C.
2. 1A	12. 2Y
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. 1B	15. 2A
6. N.C.	16. N.C.
7. 1Y	17. 2B
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. GND	20. V_{CC}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
0 to 70	SG75452BY	—
	SG75462Y	—
	SG75472Y	—
-55 to 125	SG55452BY	SG55452BL
	SG55462Y	SG55462L
	SG55472Y	SG55472L
MIL-STD-883	SG55452BY/883B	SG55452BL/883B
	SG55462Y/883B	SG55462L/883B
	SG55472Y/883B	SG55472L/883B
DESC	SG55452BY/DESC	SG55452BL/DESC
JAN	JAN55452BY	—

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG55453B/SG75453B Series

DUAL PERIPHERAL POSITIVE-OR DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55453B/SG55463/SG55473 (SG75453B/SG75463/SG75473) series of dual peripheral Positive-OR drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55453B/63/73 (SN75453B/63/73) series. Diode-clamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55453B/SG55463/SG55473 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75453B/SG75463/SG75473 drivers are characterized for operation from 0°C to 70°C.

KEY FEATURES

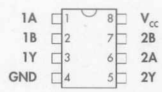
- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

HIGH RELIABILITY FEATURES

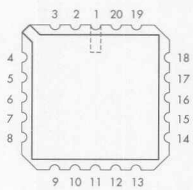
- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



1. N.C.
2. 1A
3. N.C.
4. N.C.
5. 1B
6. N.C.
7. 1Y
8. N.C.
9. N.C.
10. GND
11. N.C.
12. 2Y
13. N.C.
14. N.C.
15. 2A
16. N.C.
17. 2B
18. N.C.
19. N.C.
20. V_{cc}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
0 to 70	SG75453BY	—
	SG75463Y	—
	SG75473Y	—
-55 to 125	SG55453BY	SG55453BL
	SG55463Y	SG55463L
	SG55473Y	SG55473L
MIL-STD-883	SG55453BY/883B	SG55453BL/883B
	SG55463Y/883B	SG55463L/883B
	SG55473Y/883B	SG55473L/883B

FOR FURTHER INFORMATION CALL (714) 898-8121

11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG55454B/SG75454B Series

DUAL PERIPHERAL POSITIVE-NOR DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

DESCRIPTION

The SG55454B/SG55464/SG55474 (SG75454B/SG75464/SG75474) series of dual peripheral Positive-NOR drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55454B/64/74 (SN75454B/64/74) series. Diode-clamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55454B/SG55464/SG55474 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75453B/SG75463/SG75473 drivers are characterized for operation from 0°C to 70°C.

KEY FEATURES

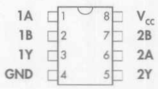
- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH-SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

HIGH RELIABILITY FEATURES

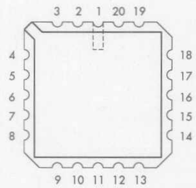
- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

PACKAGE PIN OUTS



Y PACKAGE
(Top View)



1. N.C.	11. N.C.
2. 1A	12. 2Y
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. 1B	15. 2A
6. N.C.	16. N.C.
7. 1Y	17. 2B
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. GND	20. V_{cc}

L PACKAGE
(Top View)

PACKAGE ORDER INFORMATION

T_A (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
0 to 70	SG75454BY	—
	SG75464Y	—
	SG75474Y	—
-55 to 125	SG55454BY	SG55454BL
	SG55464Y	SG55464L
	SG55474Y	SG55474L
MIL-STD-883	SG55454BY/883B	SG55454BL/883B
	SG55464Y/883B	SG55464L/883B
	SG55474Y/883B	SG55474L/883B
DESC	—	SG55454BL/DESC
	SG55464Y/DESC	SG55464L/DESC
	SG55474Y/DESC	SG55474L/DESC

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Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG5768/SG5770/SG5772/SG5774 SG6506/SG6507/SG6508/SG6509

DIODE ARRAY CIRCUITS

PRODUCTION DATA SHEET

DESCRIPTION

The Linfinity series of diode arrays feature high breakdown, high speed diodes in a variety of configurations.

Each array configuration consists of either common anode diodes, common cathode diodes, or a combination anode and common cathode diodes.

Individual diodes within the array have 60V minimum breakdown voltage, can handle 500mA of current and typically switch in less than 10 nanoseconds.

Each of the array configurations is available in ceramic DIP or ceramic flatpack and can be processed to JANTXV, JANTX, or JAN flows at Linfinity's MIL-S-19500 facility.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

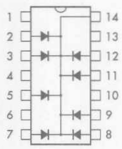
KEY FEATURES

- 60V MINIMUM BREAKDOWN VOLTAGE
- 500mA CURRENT CAPABILITY PER DIODE
- FAST SWITCHING SPEEDS: TYPICALLY LESS THAN 10ns
- LOW LEAKAGE CURRENT

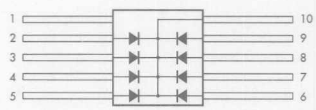
HIGH RELIABILITY FEATURES

- MIL-S-19500/474 QPL - 1N5768 - 1N6506
  - 1N5770 - 1N6507
  - 1N5772 - 1N6508
  - 1N5774 - 1N6509
- JANTXV, JANTX, JAN AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

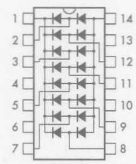
PACKAGE PIN OUTS



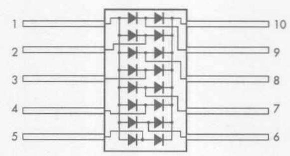
J PACKAGE
SG6506J (1N6506)



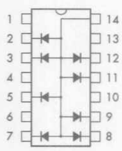
F PACKAGE
SG5768F (1N5768)



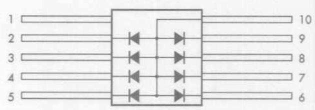
J PACKAGE
SG6508J (1N6508)



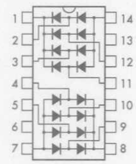
F PACKAGE
SG5772F (1N5772)



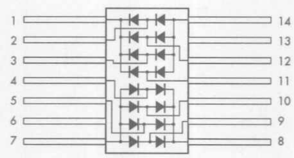
J PACKAGE
SG6507J (1N6507)



F PACKAGE
SG5770F (1N5770)



J PACKAGE
SG6509J (1N6509)



F PACKAGE
SG5774F (1N5774)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	F Ceramic Flat Pack 10-pin	F Ceramic Flat Pack 14-pin
-55 to 150	SG6506J (1N6506)	SG5768F (1N5768)	SG5774F (1N6509)
	SG6507J (1N6507)	SG5770F (1N5770)	—
	SG6508J (1N6508)	SG5772F (1N5772)	—

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11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

LINFINITY MICROELECTRONICS

THE INFINITE POWER OF INNOVATION

SG6100/6511, SG6101/6510

DIODE ARRAY CIRCUITS

PRODUCTION DATA SHEET

DESCRIPTION

The SG6100/SG6511 and SG6101/SG6510 diode arrays are monolithic, high breakdown, fast switching speed diode arrays. The SG6100/SG6511 is configured with 7 straight through diodes, while the SG6101/SG6510 has 8 straight through diodes.

These two diode array configurations allow the designer maximum flexibility for circuit design and board layout. Since each diode within the array has individual anode and cathode connections the device may be used in a variety of applications. Also, due to the array's monolithic construction the diode electrical parameters are very closely matched.

Both devices are available in ceramic DIP and flatpack and can be processed to Linfinity's S level, JANTXV, JANTX, of JAN equivalent flows.

KEY FEATURES

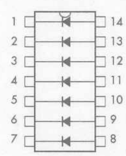
- 75V MINIMUM BREAKDOWN VOLTAGE
- 100mA CURRENT CAPABILITY PER DIODE
- SWITCHING SPEEDS LESS THAN 5ns
- LOW LEAKAGE CURRENT < 25na

HIGH RELIABILITY FEATURES

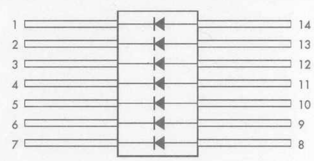
- MIL-S-19500/474 QPL - 1N6100
  - 1N6101
  - 1N6510
  - 1N6511
- EQUIVALENT JANS, JANTXV, JANTX, JAN SCREENING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

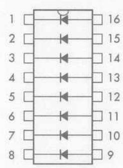
PACKAGE PIN OUTS



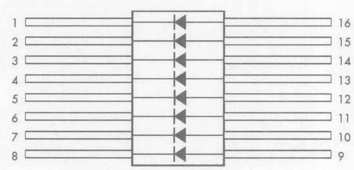
J PACKAGE
SG6511J (1N6511)



F PACKAGE
SG6100 (1N6100)



J PACKAGE
SG6101J (1N6101)



F PACKAGE
SG6510 (1N6510)

PACKAGE ORDER INFORMATION

T_A (°C)	J Ceramic DIP 14-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 14-pin	F Ceramic Flat Pack 16-pin
-55 to 150	SG6511J (1N6511)	SG6101J (1N6101)	SG6100F (1N6100)	SG6510F (1N6510)

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11861 WESTERN AVENUE, GARDEN GROVE, CA. 92841

Notes

Thumb Index

LINFINITY
MICROELECTRONICS

QML MILITARY PRODUCTS

LINFINITY Microelectronics Inc. offers a full line of Linear products which are processed in accordance with the requirements of MIL-I-38535, Qualified Manufacturers Listing (QML). Three Cross Reference Lists are provided:

- ***Cross Reference* 1** All QML military products *sorted* by Generic Part # (below),
- ***Cross Reference* 2** All MIL-M-38510 (JAN) Qualified products (Page 11-13),
- ***Cross Reference* 3** All Standard Military Drawing (SMD) Qualified products (Page 11-14).

Three categories of QML Military Specification are provided (Note: Transitional Certification pending Verification Audit by DESC.):

- **Generic /883B (MIL-STD-883, Paragraph 1.2.1 compliant)**
- **MIL-M-38510 (JAN)**
- **Standard Military Drawing (SMD)**

See Page 11-17 for a listing of all QPL Products (JAN, JANTX, and JANTXV Processing Levels).

Cross Reference 1

Listing of all QML Certified military products sorted by Generic Part #.

Generic Part # (/883B) Part No.	Pkg.	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD) (Note 1)	Description
SG103-1.8	Z		7702801X(X)	Voltage Reference 1.8V
SG103-2.4	Z			Voltage Reference 2.4V
SG103-2.7	Z		7702805X(X)	Voltage Reference 2.7V
SG103-3.3	Z			Voltage Reference 3.3V
SG103-4.7	Z		7702811X(X)	Voltage Reference 4.7V
SG103-5.1	Z			Voltage Reference 5.1V
SG109	T	10701BX(X)		Positive Fixed Voltage Regulator
SG109	K			Positive Fixed Voltage Regulator
SG109	R			Positive Fixed Voltage Regulator
SG109	IG			Positive Fixed Voltage Regulator
SG117	T	11703BX(X)	7703401X(X)	Positive Adjustable Voltage Regulator
SG117	K	11704BY(X)	7703401Y(X)	Positive Adjustable Voltage Regulator
SG117	R		7703401Z(X)	Positive Adjustable Voltage Regulator
SG117	L		77034012(X)	Positive Adjustable Voltage Regulator
SG117	IG		7703401U(X)	Positive Adjustable Voltage Regulator
SG117A	T		7703405X(X)	Positive Adjustable Voltage Regulator
SG117A	K		7703405Y(X)	Positive Adjustable Voltage Regulator
SG117A	R		7703405Z(X)	Positive Adjustable Voltage Regulator
SG117A	L		77034052(X)	Positive Adjustable Voltage Regulator
SG117A	IG		7703405U(X)	Positive Adjustable Voltage Regulator
SGR117A	T			RadHard 1.5A Adjustable Voltage Regulator
SGR117A	K			RadHard 1.5A Adjustable Voltage Regulator
SGR117A	R			RadHard 1.5A Adjustable Voltage Regulator
SGR117A	IG			RadHard 1.5A Adjustable Voltage Regulator
SG120-05	R			Negative Fixed Voltage Regulator
SG120-05	K			Negative Fixed Voltage Regulator
SG120-05	T			Negative Fixed Voltage Regulator

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG120-05	L			Negative Fixed Voltage Regulator
SG120-05	IG			Negative Fixed Voltage Regulator
SG120-5.2	R			Negative Fixed Voltage Regulator
SG120-5.2	K			Negative Fixed Voltage Regulator
SG120-5.2	T			Negative Fixed Voltage Regulator
SG120-5.2	L			Negative Fixed Voltage Regulator
SG120-5.2	IG			Negative Fixed Voltage Regulator
SG120-08	R			Negative Fixed Voltage Regulator
SG120-08	K			Negative Fixed Voltage Regulator
SG120-08	T			Negative Fixed Voltage Regulator
SG120-08	L			Negative Fixed Voltage Regulator
SG120-08	IG			Negative Fixed Voltage Regulator
SG120-12	R			Negative Fixed Voltage Regulator
SG120-12	K			Negative Fixed Voltage Regulator
SG120-12	T			Negative Fixed Voltage Regulator
SG120-12	L			Negative Fixed Voltage Regulator
SG120-12	IG			Negative Fixed Voltage Regulator
SG120-15	R			Negative Fixed Voltage Regulator
SG120-15	K			Negative Fixed Voltage Regulator
SG120-15	T			Negative Fixed Voltage Regulator
SG120-15	L			Negative Fixed Voltage Regulator
SG120-15	IG			Negative Fixed Voltage Regulator
SG120-18	R			Negative Fixed Voltage Regulator
SG120-18	K			Negative Fixed Voltage Regulator
SG120-18	T			Negative Fixed Voltage Regulator
SG120-18	L			Negative Fixed Voltage Regulator
SG120-18	IG			Negative Fixed Voltage Regulator
SG120-20	R			Negative Fixed Voltage Regulator
SG120-20	K			Negative Fixed Voltage Regulator
SG120-20	T			Negative Fixed Voltage Regulator
SG120-20	L			Negative Fixed Voltage Regulator
SG120-20	IG			Negative Fixed Voltage Regulator
SG120A-05	IG			Negative Fixed Voltage Regulator
SG120A-5.2	IG			Negative Fixed Voltage Regulator
SG120A-08	IG			Negative Fixed Voltage Regulator
SG120A-12	IG			Negative Fixed Voltage Regulator
SG120A-15	IG			Negative Fixed Voltage Regulator
SG120A-18	IG			Negative Fixed Voltage Regulator
SG120A-20	IG			Negative Fixed Voltage Regulator
SG137	T		7703403X(X)	Negative Fixed Voltage Regulator
SG137	R		7703403Z(X)	Negative Fixed Voltage Regulator

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

Cross Reference

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG137	K	11804BY(X)	7703403Y(X)	Negative Fixed Voltage Regulator
SG137	L		77034032(X)	Negative Fixed Voltage Regulator
SG137	IG		7703403U(X)	Negative Fixed Voltage Regulator
SG137A	T		7703406X(X)	Negative Adjustable Voltage Regulator - High Performance
SG137A	K		7703406Y(X)	Negative Adjustable Voltage Regulator - High Performance
SG137A	R		7703406Z(X)	Negative Adjustable Voltage Regulator - High Performance
SG137A	L		77034062(X)	Negative Adjustable Voltage Regulator - High Performance
SG137A	IG		7703406U(X)	Negative Adjustable Voltage Regulator - High Performance
SG140-05	R			Positive Fixed Voltage Regulator
SG140-05	K			Positive Fixed Voltage Regulator
SG140-05	T			Positive Fixed Voltage Regulator
SG140-05	L			Positive Fixed Voltage Regulator
SG140-05	IG			Positive Fixed Voltage Regulator
SG140-06	R			Positive Fixed Voltage Regulator
SG140-06	K			Positive Fixed Voltage Regulator
SG140-06	T			Positive Fixed Voltage Regulator
SG140-06	L			Positive Fixed Voltage Regulator
SG140-06	IG			Positive Fixed Voltage Regulator
SG140-08	R			Positive Fixed Voltage Regulator
SG140-08	K			Positive Fixed Voltage Regulator
SG140-08	T			Positive Fixed Voltage Regulator
SG140-08	L			Positive Fixed Voltage Regulator
SG140-08	IG			Positive Fixed Voltage Regulator
SG140-12	R			Positive Fixed Voltage Regulator
SG140-12	K			Positive Fixed Voltage Regulator
SG140-12	T			Positive Fixed Voltage Regulator
SG140-12	L			Positive Fixed Voltage Regulator
SG140-12	IG			Positive Fixed Voltage Regulator
SG140-15	R			Positive Fixed Voltage Regulator
SG140-15	K			Positive Fixed Voltage Regulator
SG140-15	T			Positive Fixed Voltage Regulator
SG140-15	L			Positive Fixed Voltage Regulator
SG140-15	IG			Positive Fixed Voltage Regulator
SG140-18	R			Positive Fixed Voltage Regulator
SG140-18	K			Positive Fixed Voltage Regulator
SG140-18	T			Positive Fixed Voltage Regulator
SG140-18	L			Positive Fixed Voltage Regulator
SG140-18	IG			Positive Fixed Voltage Regulator
SG140-20	R			Positive Fixed Voltage Regulator
SG140-20	K			Positive Fixed Voltage Regulator
SG140-20	T			Positive Fixed Voltage Regulator

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference

(continued)

Generic Part # (/883B) Part No.	Pkg.	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD) (Note 1)	Description
SG140-20	L			Positive Fixed Voltage Regulator
SG140-20	IG			Positive Fixed Voltage Regulator
SG140-24	R			Positive Fixed Voltage Regulator
SG140-24	K			Positive Fixed Voltage Regulator
SG140-24	T			Positive Fixed Voltage Regulator
SG140-24	L			Positive Fixed Voltage Regulator
SG140-24	IG			Positive Fixed Voltage Regulator
SG140A-05	IG			Positive Fixed Voltage Regulator
SG140A-06	IG			Positive Fixed Voltage Regulator
SG140A-08	IG			Positive Fixed Voltage Regulator
SG140A-12	IG			Positive Fixed Voltage Regulator
SG140A-15	IG			Positive Fixed Voltage Regulator
SG140A-18	IG			Positive Fixed Voltage Regulator
SG140A-20	IG			Positive Fixed Voltage Regulator
SG140A-24	IG			Positive Fixed Voltage Regulator
SG143	T		7800303Y(X)	High-Voltage Op-Amp
SG143	Y		7800303P(X)	High-Voltage Op-Amp
SG723	T	10201BI(X)		Positive Adjustable Voltage Regulator
SG723	J	10201BC(X)		Positive Adjustable Voltage Regulator
SG723	F	10201BH(X)		Positive Adjustable Voltage Regulator
SG723	L			Positive Adjustable Voltage Regulator
SG1503	T		8686101Y(X)	Precision 2.5 Volt Reference
SG1503	Y		8686101P(X)	Precision 2.5 Volt Reference
SG1524	J	12601BE(X)	7802801E(X)	Regulating PWM
SG1524	L			Regulating PWM
SG1524B	J		8764501E(X)	Regulating PWM
SG1524B	L			Regulating PWM
SG1525A	J	12602BE(X)	8951101E(X)	Regulation PWM
SG1525A	L			Regulating PWM
SG1526	J			Regulating PWM
SG1526	L			Regulating PWM
SG1526B	J	12603BV(X)	8551501V(X)	Regulating PWM
SG1526B	L			Regulating PWM
SG1527A	J	12604BE(X)	8951102E(X)	Regulating PWM
SG1527A	L			Regulating PWM
SG1529	J			Voltage Mode Feed Forward PWM Controller
SG1532	T		8777001I(X)	High Precision Positive Adjustable Voltage Regulator
SG1532	J		8777001C(X)	High Precision Positive Adjustable Voltage Regulator
SG1532	L			High Precision Positive Adjustable Voltage Regulator
SG1536	T		7800304X(X)	High-Voltage Op-Amp
SG1536	Y		7800304P(X)	High-Voltage Op-Amp

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference

(continued)

Generic Part # (/883B) Part No.	Pkg.	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD) (Note 1)	Description
SG1540	Y			Off-Line Start-Up Controller
SG1543	J		8774001E(X)	Precision Voltage Supervisor
SG1543	L			Precision Voltage Supervisor
SG1544	J		8774002V(X)	Precision Voltage Supervisor
SG1548	J		8987801E(X)	Quad Fault Monitor
SG1548	L			Quad Fault Monitor
SG1549	Y		8684901P(X)	Current Sense Latch
SG1626	Y		8871601P(X)	Hi-Speed MOSFET Dual Driver, Inverting
SG1626	J		8871601C(X)	Hi-Speed MOSFET Dual Driver, Inverting
SG1626	T		8871601G(X)	Hi-Speed MOSFET Dual Driver, Inverting
SG1626	R		8871601X(X)	Hi-Speed MOSFET Dual Driver, Inverting
SG1626	L			Hi-Speed MOSFET Dual Driver, Inverting
SG1635	R			Half-Bridge Driver
SG1644	Y		9165301MP(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting
SG1644	J		9165301MC(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting
SG1644	T		9165301MG(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting
SG1644	R			Hi-Speed MOSFET Dual Driver, Non-Inverting
SG1644	L		9165301M2(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting
SG1731	J			DC Motor PWM
SG1731	L			DC Motor PWM
LX1823M	J			High-Speed Current Mode PWM
SG1825C	J		8768101E(X)	High-Speed Current Mode PWM
SG1825C	L		87681012(X)	High-Speed Current Mode PWM
SG1842	Y		8670401P(X)	Current-Mode PWM Controller
SG1842	J		8670401E(X)	Current-Mode PWM Controller
SG1842	F		8670401H(X)	Current-Mode PWM Controller
SG1842	L		86704012(X)	Current-Mode PWM Controller
SG1843	Y		8670402P(X)	Current-Mode PWM Controller
SG1843	J		8670402C(X)	Current-Mode PWM Controller
SG1843	F		8670402H(X)	Current-Mode PWM Controller
SG1843	L		86704022(X)	Current-Mode PWM Controller
SG1844	Y		8670403P(X)	Current Mode PWM Controller
SG1844	J		8670403E(X)	Current Mode PWM Controller
SG1844	F		8670403H(X)	Current Mode PWM Controller
SG1844	L		86704032(X)	Current Mode PWM Controller
SG1844	L		86704032(X)	Current Mode PWM Controller
SG1844	L		86704032(X)	Current Mode PWM Controller
SG1845	Y		8670404P(X)	Current Mode PWM Controller
SG1845	J		8670404E(X)	Current Mode PWM Controller
SG1845	F		8670404H(X)	Current Mode PWM Controller
SG1845	L		86704042(X)	Current Mode PWM Controller

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

APPROVED QML/QPL LISTINGS

All QML Products

Cross Reference

(continued)

Generic Part # (/883B) Part No.	Pkg.	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD) (Note 1)	Description
SG1846	J		8680601E(X)	Current-Mode PWM
SG1846	F		8680601F(X)	Current-Mode PWM
SG1846	L		86806012(X)	Current-Mode PWM
SG2001	J	14101BE(X)		Hi-Voltage, Medium Current Driver Array
SG2001	L			Hi-Voltage, Medium Current Driver Array
SG2002	J	14102BE(X)		Hi-Voltage, Medium Current Driver Array
SG2002	L			Hi-Voltage, Medium Current Driver Array
SG2003	J	14103BE(X)		Hi-Voltage, Medium Current Driver Array
SG2003	L			Hi-Voltage, Medium Current Driver Array
SG2004	J	14104BE(X)		Hi-Voltage, Medium Current Driver Array
SG2004	L			Hi-Voltage, Medium Current Driver Array
SG2011	J			Hi-Voltage, Medium Current Driver Array
SG2011	L			Hi-Voltage, Medium Current Driver Array
SG2012	J			Hi-Voltage, Medium Current Driver Array
SG2012	L			Hi-Voltage, Medium Current Driver Array
SG2013	J			Hi-Voltage, Medium Current Driver Array
SG2013	L			Hi-Voltage, Medium Current Driver Array
SG2014	J			Hi-Voltage, Medium Current Driver Array
SG2014	L			Hi-Voltage, Medium Current Driver Array
SG2021	J			Hi-Voltage, Medium Current Driver Array
SG2021	L			Hi-Voltage, Medium Current Driver Array
SG2022	J			Hi-Voltage, Medium Current Driver Array
SG2022	L			Hi-Voltage, Medium Current Driver Array
SG2023	J		8987601E(X)	Hi-Voltage, Medium Current Driver Array
SG2023	L			Hi-Voltage, Medium Current Driver Array
SG2024	J			Hi-Voltage, Medium Current Driver Array
SG2024	L			Hi-Voltage, Medium Current Driver Array
SG2074	J			Quad 1.5A Darlington Switches
SG2801	J	14106BV(X)		Hi-Voltage, Medium Current Driver Array
SG2801	L			Hi-Voltage, Medium Current Driver Array
SG2802	J	14107BV(X)		Hi-Voltage, Medium Current Driver Array
SG2802	L			Hi-Voltage, Medium Current Driver Array
SG2803	J	14108BV(X)	8605801V(X)	Hi-Voltage, Medium Current Driver Array
SG2803	L		86058012(X)	Hi-Voltage, Medium Current Driver Array
SG2804	J	14109BV(X)		Hi-Voltage, Medium Current Driver Array
SG2804	L			Hi-Voltage, Medium Current Driver Array
SG2811	J			Hi-Voltage, Medium Current Driver Array
SG2811	L			Hi-Voltage, Medium Current Driver Array
SG2812	J			Hi-Voltage, Medium Current Driver Array
SG2812	L			Hi-Voltage, Medium Current Driver Array
SG2813	J			Hi-Voltage, Medium Current Driver Array

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

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Cross Reference

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG2813	L			Hi-Voltage, Medium Current Driver Array
SG2814	J			Hi-Voltage, Medium Current Driver Array
SG2814	L			Hi-Voltage, Medium Current Driver Array
SG2821	J		8968401V(X)	Hi-Voltage, Medium Current Driver Array
SG2821	L		89684012(X)	Hi-Voltage, Medium Current Driver Array
SG2822	J			Hi-Voltage, Medium Current Driver Array
SG2822	L			Hi-Voltage, Medium Current Driver Array
SG2823	J		8968501V(X)	Hi-Voltage, Medium Current Driver Array
SG2823	L		89685012(X)	Hi-Voltage, Medium Current Driver Array
SG2824	J		8968601V(X)	Hi-Voltage, Medium Current Driver Array
SG2824	L		89686012(X)	Hi-Voltage, Medium Current Driver Array
SG3081	J		8866401E(X)	Transistor Array
SG7805	K	10706BY(X)		Positive Fixed Voltage Regulator - 5V
SG7805	R			Positive Fixed Voltage Regulator - 5V
SG7805	T	10702BX(X)		Positive Fixed Voltage Regulator - 5V
SG7805	IG			Positive Fixed Voltage Regulator - 5V
SG7805A	L		88746012(X)	Positive Fixed Voltage Regulator - 5V
SG7805A	K		8778201Y(X)	Positive Fixed Voltage Regulator - 5V
SG7805A	R		8778201Z(X)	Positive Fixed Voltage Regulator - 5V
SG7805A	T		8778201X(X)	Positive Fixed Voltage Regulator - 5V
SG7805A	IG		8778201U(X)	Positive Fixed Voltage Regulator - 5V
SG7805A	L		87782012(X)	Positive Fixed Voltage Regulator - 5V
SG7806	K			Positive Fixed Voltage Regulator - 6V
SG7806	R			Positive Fixed Voltage Regulator - 6V
SG7806	T			Positive Fixed Voltage Regulator - 6V
SG7806	IG			Positive Fixed Voltage Regulator - 6V
SG7806	L			Positive Fixed Voltage Regulator - 6V
SG7806A	K		8962601Y(X)	Positive Fixed Voltage Regulator - 6V
SG7806A	R		8962601Z(X)	Positive Fixed Voltage Regulator - 6V
SG7806A	T		8962601X(X)	Positive Fixed Voltage Regulator - 6V
SG7806A	IG			Positive Fixed Voltage Regulator - 6V
SG7808	K			Positive Fixed Voltage Regulator - 8V
SG7808	R			Positive Fixed Voltage Regulator - 8V
SG7808	T			Positive Fixed Voltage Regulator - 8V
SG7808	IG			Positive Fixed Voltage Regulator - 8V
SG7808	L			Positive Fixed Voltage Regulator - 8V
SG7808A	K		8962801Y(X)	Positive Fixed Voltage Regulator - 8V
SG7808A	R		8962801Z(X)	Positive Fixed Voltage Regulator - 8V
SG7808A	T		8962801X(X)	Positive Fixed Voltage Regulator - 8V
SG7808A	IG			Positive Fixed Voltage Regulator - 8V
SG7812	K	10707BY(X)		Positive Fixed Voltage Regulator - 12V

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

1 Cross Reference

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG7812	R			Positive Fixed Voltage Regulator - 12V
SG7812	T	10703BX(X)		Positive Fixed Voltage Regulator - 12V
SG7812	IG			Positive Fixed Voltage Regulator - 12V
SG7812	L			Positive Fixed Voltage Regulator - 12V
SG7812A	K		8777601Y(X)	Positive Fixed Voltage Regulator - 12V
SG7812A	R		8777601Z(X)	Positive Fixed Voltage Regulator - 12V
SG7812A	T		8777601X(X)	Positive Fixed Voltage Regulator - 12V
SG7812A	IG		8777601U(X)	Positive Fixed Voltage Regulator - 12V
SG7812A	L		87776012(X)	Positive Fixed Voltage Regulator - 12V
SG7815	K	10708BY(X)		Positive Fixed Voltage Regulator - 15V
SG7815	R			Positive Fixed Voltage Regulator - 15V
SG7815	T	10704BX(X)		Positive Fixed Voltage Regulator - 15V
SG7815	IG			Positive Fixed Voltage Regulator - 15V
SG7815	L			Positive Fixed Voltage Regulator - 15V
SG7815A	K		8855301Y(X)	Positive Fixed Voltage Regulator - 15V
SG7815A	R		8855301Z(X)	Positive Fixed Voltage Regulator - 15V
SG7815A	T		8855301X(X)	Positive Fixed Voltage Regulator - 15V
SG7815A	IG		8855301U(X)	Positive Fixed Voltage Regulator - 15V
SG7815A	L		88553012(X)	Positive Fixed Voltage Regulator - 15V
SG7818	K			Positive Fixed Voltage Regulator - 18V
SG7818	R			Positive Fixed Voltage Regulator - 18V
SG7818	T			Positive Fixed Voltage Regulator - 18V
SG7818	IG			Positive Fixed Voltage Regulator - 18V
SG7818	L			Positive Fixed Voltage Regulator - 18V
SG7818A	K			Positive Fixed Voltage Regulator - 18V
SG7818A	R			Positive Fixed Voltage Regulator - 18V
SG7818A	T			Positive Fixed Voltage Regulator - 18V
SG7818A	IG			Positive Fixed Voltage Regulator - 18V
SG7820	K			Positive Fixed Voltage Regulator - 20V
SG7820	R			Positive Fixed Voltage Regulator - 20V
SG7820	T			Positive Fixed Voltage Regulator - 20V
SG7820	IG			Positive Fixed Voltage Regulator - 20V
SG7820	L			Positive Fixed Voltage Regulator - 20V
SG7820A	K		9152301Y(X)	Positive Fixed Voltage Regulator - 20V
SG7820A	R		9152301Z(X)	Positive Fixed Voltage Regulator - 20V
SG7820A	T		9152301X(X)	Positive Fixed Voltage Regulator - 20V
SG7820A	IG		9152301U(X)	Positive Fixed Voltage Regulator - 20V
SG7824A	K			Positive Fixed Voltage Regulator - 24V
SG7824	K			Positive Fixed Voltage Regulator - 24V
SG7824	R			Positive Fixed Voltage Regulator - 24V
SG7824	T			Positive Fixed Voltage Regulator - 24V

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG7824	IG			Positive Fixed Voltage Regulator - 24V
SG7824	L			Positive Fixed Voltage Regulator - 24V
SG7824A	K		8855401Y(X)	Positive Fixed Voltage Regulator - 24V
SG7824A	R		8855401Z(X)	Positive Fixed Voltage Regulator - 24V
SG7824A	T		8855401X(X)	Positive Fixed Voltage Regulator - 24V
SG7824A	IG			Positive Fixed Voltage Regulator - 24V
SG7905	K	11505BY(X)		Negative Fixed Voltage Regulator - 5V
SG7905	R			Negative Fixed Voltage Regulator - 5V
SG7905	T	11501BX(X)		Negative Fixed Voltage Regulator - 5V
SG7905	IG			Negative Fixed Voltage Regulator - 5V
SG7905	L			Negative Fixed Voltage Regulator - 5V
SG7905A	K		8874601Y(X)	Negative Fixed Voltage Regulator - 5V
SG7905A	R		8874601Z(X)	Negative Fixed Voltage Regulator - 5V
SG7905A	T		8874601X(X)	Negative Fixed Voltage Regulator - 5V
SG7905A	IG		8874601U(X)	Negative Fixed Voltage Regulator - 5V
SG7905.2	K			Negative Fixed Voltage Regulator - 5.2V
SG7905.2	R			Negative Fixed Voltage Regulator - 5.2V
SG7905.2	T			Negative Fixed Voltage Regulator - 5.2V
SG7905.2	IG			Negative Fixed Voltage Regulator - 5.2V
SG7905.2	L			Negative Fixed Voltage Regulator - 5.2V
SG7905.2A	K			Negative Fixed Voltage Regulator - 5.2V
SG7905.2A	R			Negative Fixed Voltage Regulator - 5.2V
SG7905.2A	T			Negative Fixed Voltage Regulator - 5.2V
SG7905.2A	IG			Negative Fixed Voltage Regulator - 5.2V
SG7908	K			Negative Fixed Voltage Regulator - 8V
SG7908	R			Negative Fixed Voltage Regulator - 8V
SG7908	T			Negative Fixed Voltage Regulator - 8V
SG7908	IG			Negative Fixed Voltage Regulator - 8V
SG7908	L			Negative Fixed Voltage Regulator - 8V
SG7908A	K		8987001Y(X)	Negative Fixed Voltage Regulator - 8V
SG7908A	R		8987001Z(X)	Negative Fixed Voltage Regulator - 8V
SG7908A	T		8987001X(X)	Negative Fixed Voltage Regulator - 8V
SG7908A	IG		8987001U(X)	Negative Fixed Voltage Regulator - 8V
SG7912	K	11506BY(X)		Negative Fixed Voltage Regulator - 12V
SG7912	R			Negative Fixed Voltage Regulator - 12V
SG7912	T	11502BX(X)		Negative Fixed Voltage Regulator - 12V
SG7912	IG			Negative Fixed Voltage Regulator - 12V
SG7912	L			Negative Fixed Voltage Regulator - 12V
SG7912A	K		8874701Y(X)	Negative Fixed Voltage Regulator - 12V
SG7912A	R		8874701Z(X)	Negative Fixed Voltage Regulator - 12V
SG7912A	T		8874701X(X)	Negative Fixed Voltage Regulator - 12V

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference

(continued)

Generic Part # (/883B) Part No.	Pkg.	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD) (Note 1)	Description
SG7912A	IG		8874701U(X)	Negative Fixed Voltage Regulator - 12V
SG7915	K	11507BY(X)		Negative Fixed Voltage Regulator - 15V
SG7915	R			Negative Fixed Voltage Regulator - 15V
SG7915	T	11503BX(X)		Negative Fixed Voltage Regulator - 15V
SG7915	IG			Negative Fixed Voltage Regulator - 15V
SG7915	L			Negative Fixed Voltage Regulator - 15V
SG7915A	K		8874801Y(X)	Negative Fixed Voltage Regulator - 15V
SG7915A	R		8874801Z(X)	Negative Fixed Voltage Regulator - 15V
SG7915A	T		8874801X(X)	Negative Fixed Voltage Regulator - 15V
SG7915A	IG		8874801U(X)	Negative Fixed Voltage Regulator - 15V
SG7918	K			Negative Fixed Voltage Regulator - 18V
SG7918	R			Negative Fixed Voltage Regulator - 18V
SG7918	T			Negative Fixed Voltage Regulator - 18V
SG7918	IG			Negative Fixed Voltage Regulator - 18V
SG7918	L			Negative Fixed Voltage Regulator - 18V
SG7918A	K			Negative Fixed Voltage Regulator - 18V
SG7918A	R			Negative Fixed Voltage Regulator - 18V
SG7918A	T			Negative Fixed Voltage Regulator - 18V
SG7918A	IG			Negative Fixed Voltage Regulator - 18V
SG7920	K			Negative Fixed Voltage Regulator - 20V
SG7920	R			Negative Fixed Voltage Regulator - 20V
SG7920	T			Negative Fixed Voltage Regulator - 20V
SG7920	IG			Negative Fixed Voltage Regulator - 20V
SG7920	L			Negative Fixed Voltage Regulator - 20V
SG7920A	K			Negative Fixed Voltage Regulator - 20V
SG7920A	R			Negative Fixed Voltage Regulator - 20V
SG7920A	T			Negative Fixed Voltage Regulator - 20V
SG7920A	IG			Negative Fixed Voltage Regulator - 20V
SG7924	K	11508BY(X)		Negative Fixed Voltage Regulator - 24V
SG55236	F			Undervoltage Sensing Circuit
SG55325	F	13001BF(X)		Dual Source/Sink Memory Driver
SG55325	J	13001BE(X)		Dual Source/Sink Memory Driver
SG55325	L			Dual Source/Sink Memory Driver
SG55326	F			Quad Core Memory Driver
SG55326	J	13002BE(X)		Quad Core Memory Driver
SG55326	L			Quad Core Memory Driver
SG55327	F			Quad Core Memory Driver
SG55327	J			Quad Core Memory Driver
SG55327	L			Quad Core Memory Driver
SG55450B	J			Dual Peripheral Driver
SG55450B	L			Dual Peripheral Driver

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

All QML Products

Cross Reference 1

(continued)

Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG55451B	Y			Dual Peripheral Driver
SG55451B	L			Dual Peripheral Driver
SG55452B	Y	12903BP(X)	7704901P(X)	Dual Peripheral Driver
SG55452B	L		77049012(X)	Dual Peripheral Driver
SG55453B	Y			Dual Peripheral Driver
SG55453B	L			Dual Peripheral Driver
SG55454B	Y			Dual Peripheral Driver
SG55454B	L		88715012(X)	Dual Peripheral Driver
SG55460	J			Dual Peripheral Driver
SG55460	L			Dual Peripheral Driver
SG55461	Y			Dual Peripheral Driver
SG55461	L			Dual Peripheral Driver
SG55462	Y			Dual Peripheral Driver
SG55462	L			Dual Peripheral Driver
SG55463	Y			Dual Peripheral Driver
SG55463	L			Dual Peripheral Driver
SG55464	Y		8871502P(X)	Dual Peripheral Driver
SG55464	L		88715022(X)	Dual Peripheral Driver
SG55470	J			Dual Peripheral Driver
SG55470	L			Dual Peripheral Driver
SG55471	Y			Dual Peripheral Driver
SG55471	L			Dual Peripheral Driver
SG55472	Y			Dual Peripheral Driver
SG55472	L			Dual Peripheral Driver
SG55473	Y			Dual Peripheral Driver
SG55473	L			Dual Peripheral Driver
SG55474	Y		8871503P(X)	Dual Peripheral Driver
SG55474	L		88715032(X)	Dual Peripheral Driver

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

End Cross Reference 1

LINFINITY MICROELECTRONICS

Cross Reference 2

Listing of all MIL-M-38510 (JAN) Qualified products.

MIL-M-38510 (JAN)	Generic Part #		Description
(Note 1)	Part No.	Pkg.	
10201BC(X)	SG723	J	Positive Adjustable Voltage Regulator
10201BH(X)	SG723	F	Positive Adjustable Voltage Regulator
10201BI(X)	SG723	T	Positive Adjustable Voltage Regulator
10701BX(X)	SG109	T	Positive Fixed Voltage Regulator
10702BX(X)	SG7805	T	Positive Fixed Voltage Regulator - 5V
10703BX(X)	SG7812	T	Positive Fixed Voltage Regulator - 12V
10704BX(X)	SG7815	T	Positive Fixed Voltage Regulator - 15V
10706BY(X)	SG7805	K	Positive Fixed Voltage Regulator - 5V
10707BY(X)	SG7812	K	Positive Fixed Voltage Regulator - 12V
10708BY(X)	SG7815	K	Positive Fixed Voltage Regulator - 15V
11501BX(X)	SG7905	T	Negative Fixed Voltage Regulator - 5V
11502BX(X)	SG7912	T	Negative Fixed Voltage Regulator - 12V
11503BX(X)	SG7915	T	Negative Fixed Voltage Regulator - 15V
11505BY(X)	SG7905	K	Negative Fixed Voltage Regulator - 5V
11506BY(X)	SG7912	K	Negative Fixed Voltage Regulator - 12V
11507BY(X)	SG7915	K	Negative Fixed Voltage Regulator - 15V
11508BY(X)	SG7924	K	Negative Fixed Voltage Regulator - 24V
11703BX(X)	SG117	T	Positive Adjustable Voltage Regulator
11704BY(X)	SG117	K	Positive Adjustable Voltage Regulator
11804BY(X)	SG137	K	Negative Fixed Voltage Regulator
12601BE(X)	SG1524	J	Regulating PWM
12602BE(X)	SG1525A	J	Regulation PWM
12603BV(X)	SG1526B	J	Regulating PWM
12604BE(X)	SG1527A	J	Regulating PWM
12903BP(X)	SG55452B	Y	Dual Peripheral Driver
13001BE(X)	SG55325	J	Dual Source/Sink Memory Driver
13001BF(X)	SG55325	F	Dual Source/Sink Memory Driver
13002BE(X)	SG55326	J	Quad Core Memory Driver
14101BE(X)	SG2001	J	Hi-Voltage, Medium Current Driver Array
14102BE(X)	SG2002	J	Hi-Voltage, Medium Current Driver Array
14103BE(X)	SG2003	J	Hi-Voltage, Medium Current Driver Array
14104BE(X)	SG2004	J	Hi-Voltage, Medium Current Driver Array
14106BV(X)	SG2801	J	Hi-Voltage, Medium Current Driver Array
14107BV(X)	SG2802	J	Hi-Voltage, Medium Current Driver Array
14108BV(X)	SG2803	J	Hi-Voltage, Medium Current Driver Array
14109BV(X)	SG2804	J	Hi-Voltage, Medium Current Driver Array

Note 1: (X) denotes unspecified lead finish.

End Cross Reference 2

Military Products

APPROVED QML/QPL LISTINGS

SMD (DESC) Products

Cross Reference

Listing of all Standard Military Drawing (SMD) Qualified products.

Standard MIL Drawing (SMD)	Generic Part # (DESC)		Description
(Note 1)	Part No.	Pkg.	
7702801X(X)	SG103-1.8	Z	Voltage Reference 1.8V
7702805X(X)	SG103-2.7	Z	Voltage Reference 2.7V
7702811X(X)	SG103-4.7	Z	Voltage Reference 4.7V
77034012(X)	SG117	L	Positive Adj. Voltage Regulator
7703401U(X)	SG117	IG	Positive Adj. Voltage Regulator
7703401X(X)	SG117	T	Positive Adj. Voltage Regulator
7703401Y(X)	SG117	K	Positive Adj. Voltage Regulator
7703401Z(X)	SG117	R	Positive Adj. Voltage Regulator
77034032(X)	SG137	L	Neg. Fixed Voltage Regulator
7703403U(X)	SG137	IG	Neg. Fixed Voltage Regulator
7703403X(X)	SG137	T	Neg. Fixed Voltage Regulator
7703403Y(X)	SG137	K	Neg. Fixed Voltage Regulator
7703403Z(X)	SG137	R	Neg. Fixed Voltage Regulator
77034052(X)	SG117A	L	Positive Adjustable Voltage Regulator
7703405U(X)	SG117A	IG	Positive Adjustable Voltage Regulator
7703405X(X)	SG117A	T	Positive Adjustable Voltage Regulator
7703405Y(X)	SG117A	K	Positive Adjustable Voltage Regulator
7703405Z(X)	SG117A	R	Positive Adjustable Voltage Regulator
77034062(X)	SG137A	L	Neg. Adj. Voltage Reg. - High Perf.
7703406U(X)	SG137A	IG	Neg. Adj. Voltage Reg. - High Perf.
7703406X(X)	SG137A	T	Neg. Adj. Voltage Reg. - High Perf.
7703406Y(X)	SG137A	K	Neg. Adj. Voltage Reg. - High Perf.
7703406Z(X)	SG137A	R	Neg. Adj. Voltage Reg. - High Perf.
77049012(X)	SG55452B	L	Dual Peripheral Driver
7704901P(X)	SG55452B	Y	Dual Peripheral Driver
7800303P(X)	SG143	Y	High-Voltage Op-Amp
7800303X(X)	SG143	T	High-Voltage Op-Amp
7800304P(X)	SG1536	Y	High-Voltage Op-Amp
7800304X(X)	SG1536	T	High-Voltage Op-Amp
7802801E(X)	SG1524	J	Regulating PWM
8551501V(X)	SG1526B	J	Regulating PWM
86058012(X)	SG2803	L	Hi-Voltage, Med. Curr. Driver Array
8605801V(X)	SG2803	J	Hi-Voltage, Med. Curr. Driver Array
86704012(X)	SG1842	L	Current-Mode PWM
8670401C(X)	SG1842	J (14)	Current-Mode PWM
8670401E(X)	SG1842	J (16)	Current-Mode PWM
8670401H(X)	SG1842	F	Current-Mode PWM
8670401P(X)	SG1842	Y	Current-Mode PWM
86704022(X)	SG1843	L	Current-Mode PWM
8670402C(X)	SG1843	J	Current-Mode PWM
8670402H(X)	SG1843	F	Current-Mode PWM

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

LINFINITY MICROELECTRONICS

SMD (DESC) Products

Cross Reference

(continued)

Standard MIL Drawing (SMD)	Generic Part # (DESC)		Description
(Note 1)	Part No.	Pkg.	
8670402P(X)	SG1843	Y	Current-Mode PWM
86704032(X)	SG1844	L	Current Mode PWM Controller
8670403C(X)	SG1844	J (14)	Current Mode PWM Controller
8670403E(X)	SG1844	J (16)	Current Mode PWM Controller
8670403H(X)	SG1844	F	Current Mode PWM Controller
8670403P(X)	SG1844	Y	Current Mode PWM Controller
86704042(X)	SG1845	L	Current Mode PWM Controller
8670404C(X)	SG1845	J (14)	Current Mode PWM Controller
8670404E(X)	SG1845	J (16)	Current Mode PWM Controller
8670404H(X)	SG1845	F	Current Mode PWM Controller
8670404P(X)	SG1845	Y	Current Mode PWM Controller
86806012(X)	SG1846	L	Current-Mode PWM
8680601E(X)	SG1846	J	Current-Mode PWM
8680601F(X)	SG1846	F	Current-Mode PWM
8684901P(X)	SG1549	Y	Current Sense Latch
8686101P(X)	SG1503	Y	Precision 2.5 Volt Reference
8686101Y(X)	SG1503	T	Precision 2.5 Volt Reference
8764501E(X)	SG1524B	J	Regulating PWM
87681012(X)	SG1825C	L	High-Speed Current Mode PWM
8768101E(X)	SG1825C	J	High-Speed Current Mode PWM
8774001E(X)	SG1543	J	Precision Voltage Supervisor
8774002V(X)	SG1544	J	Precision Voltage Supervisor
8777001C(X)	SG1532	J	High Precision Positive Adjustable Voltage Regulator
8777001I(X)	SG1532	T	High Precision Positive Adjustable Voltage Regulator
87776012(X)	SG7812A	L	Positive Fixed Voltage Regulator - 12V
8777601U(X)	SG7812A	IG	Positive Fixed Voltage Regulator - 12V
8777601X(X)	SG7812A	T	Positive Fixed Voltage Regulator - 12V
8777601Y(X)	SG7812A	K	Positive Fixed Voltage Regulator - 12V
8777601Z(X)	SG7812A	R	Positive Fixed Voltage Regulator - 12V
87782012(X)	SG7805A	L	Positive Fixed Voltage Regulator - 5V
8778201U(X)	SG7805A	IG	Positive Fixed Voltage Regulator - 5V
8778201X(X)	SG7805A	T	Positive Fixed Voltage Regulator - 5V
8778201Y(X)	SG7805A	K	Positive Fixed Voltage Regulator - 5V
8778201Z(X)	SG7805A	R	Positive Fixed Voltage Regulator - 5V
88553012(X)	SG7815A	L	Positive Fixed Voltage Regulator - 15V
8855301U(X)	SG7815A	IG	Positive Fixed Voltage Regulator - 15V
8855301X(X)	SG7815A	T	Positive Fixed Voltage Regulator - 15V
8855301Y(X)	SG7815A	K	Positive Fixed Voltage Regulator - 15V
8855301Z(X)	SG7815A	R	Positive Fixed Voltage Regulator - 15V
8855401X(X)	SG7824A	T	Positive Fixed Voltage Regulator - 24V
8855401Y(X)	SG7824A	K	Positive Fixed Voltage Regulator - 24V

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)

Cross Reference

(continued)

Standard MIL Drawing (SMD) (Note 1)	Generic Part # (DESC) Part No.	Pkg.	Description
8855401Z(X)	SG7824A	R	Positive Fixed Voltage Regulator - 24V
8866401E(X)	SG3081	J	Transistor Array
88715012(X)	SG55454B	L	Dual Peripheral Driver
88715022(X)	SG55464	L	Dual Peripheral Driver
8871502P(X)	SG55464	Y	Dual Peripheral Driver
88715032(X)	SG55474	L	Dual Peripheral Driver
8871503P(X)	SG55474	Y	Dual Peripheral Driver
8871601C(X)	SG1626	J	Hi-Speed MOSFET Dual Driver, Inverted
8871601G(X)	SG1626	T	Hi-Speed MOSFET Dual Driver, Inverted
8871601P(X)	SG1626	Y	Hi-Speed MOSFET Dual Driver, Inverted
8871601X(X)	SG1626	R	Hi-Speed MOSFET Dual Driver, Inverted
88746012(X)	SG7905A	L	Negative Fixed Voltage Regulator - 5V
8874601U(X)	SG7905A	IG	Negative Fixed Voltage Regulator - 5V
8874601X(X)	SG7905A	T	Negative Fixed Voltage Regulator - 5V
8874601Y(X)	SG7905A	K	Negative Fixed Voltage Regulator - 5V
8874601Z(X)	SG7905A	R	Negative Fixed Voltage Regulator - 5V
8874701U(X)	SG7912A	IG	Negative Fixed Voltage Regulator - 12V
8874701X(X)	SG7912A	T	Negative Fixed Voltage Regulator - 12V
8874701Y(X)	SG7912A	K	Negative Fixed Voltage Regulator - 12V
8874701Z(X)	SG7912A	R	Negative Fixed Voltage Regulator - 12V
88748012(X)	SG7915A	L	Negative Fixed Voltage Regulator - 15V
8874801U(X)	SG7915A	IG	Negative Fixed Voltage Regulator - 15V
8874801X(X)	SG7915A	T	Negative Fixed Voltage Regulator - 15V
8874801Y(X)	SG7915A	K	Negative Fixed Voltage Regulator - 15V
8874801Z(X)	SG7915A	R	Negative Fixed Voltage Regulator - 15V
8951101E(X)	SG1525A	J	Regulation PWM
8951102E(X)	SG1527A	J	Regulating PWM
8962601X(X)	SG7806A	T	Positive Fixed Voltage Regulator - 6V
8962601Y(X)	SG7806A	K	Positive Fixed Voltage Regulator - 6V
8962601Z(X)	SG7806A	R	Positive Fixed Voltage Regulator - 6V
8962801X(X)	SG7808A	T	Positive Fixed Voltage Regulator - 8V
8962801Y(X)	SG7808A	K	Positive Fixed Voltage Regulator - 8V
8962801Z(X)	SG7808A	R	Positive Fixed Voltage Regulator - 8V
89684012(X)	SG2821	L	Hi-Voltage, Medium Current Driver Array
8968401V(X)	SG2821	J	Hi-Voltage, Medium Current Driver Array
89685012(X)	SG2823	L	Hi-Voltage, Medium Current Driver Array
8968501V(X)	SG2823	J	Hi-Voltage, Medium Current Driver Array
89686012(X)	SG2824	L	Hi-Voltage, Medium Current Driver Array
8968601V(X)	SG2824	J	Hi-Voltage, Medium Current Driver Array
8987001U(X)	SG7908A	IG	Negative Fixed Voltage Regulator - 8V
8987001X(X)	SG7908A	T	Negative Fixed Voltage Regulator - 8V

Note 1: **a.** This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

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LINFINITY MICROELECTRONICS

Cross Reference 3

(continued)

Standard MIL Drawing (SMD) (Note 1)	Generic Part # (DESC) Part No.	Pkg.	Description
8987001Y(X)	SG7908A	K	Negative Fixed Voltage Regulator - 8V
8987001Z(X)	SG7908A	R	Negative Fixed Voltage Regulator - 8V
8987601E(X)	SG2023	J	Hi-Voltage, Medium Current Driver Array
8987801E(X)	SG1548	J	Quad Fault Monitor
9152301U(X)	SG7820A	IG	Positive Fixed Voltage Regulator - 20V
9152301X(X)	SG7820A	T	Positive Fixed Voltage Regulator - 20V
9152301Y(X)	SG7820A	K	Positive Fixed Voltage Regulator - 20V
9152301Z(X)	SG7820A	R	Positive Fixed Voltage Regulator - 20V
9165301M2(X)	SG1644	J	High-Speed MOSFET Dual Driver, Non-Inverted
9165301MC(X)	SG1644	T	High-Speed MOSFET Dual Driver, Non-Inverted
9165301MG(X)	SG1644	Y	High-Speed MOSFET Dual Driver, Non-Inverted
9165301MP(X)	SG1644	L	High-Speed MOSFET Dual Driver, Non-Inverted
9669901ME(X)	SG1731	J	DC Motor Pulse Width Modulator

End Cross Reference 3

QPL MILITARY PRODUCTS - MIL-S-19500

LINFINITY Microelectronics Inc offers a line of Diode Arrays which are manufacturered in compliance with MIL-S-19500/474 and processed to JANTXV, JANTX, and JAN specification levels. These devices are listed in the QPL-19500.

Cross Reference

MIL-S-19500 QUALIFICATIONS (QPL)

Process Levels	Part #	Pkg.	Description
J, JTX, JTXV	**1N5768**	**F**	8 Common Cathode Diode Array
J, JTX, JTXV	**1N5770**	**F**	8 Common Anode Diode Array
J, JTX, JTXV	**1N5772**	**F**	16 Diode Array
J, JTX, JTXV	**1N5774**	**F**	Dual 4 Common Anode, 4 Common Cathode
J, JTX, JTXV	**1N6100**	**F**	7 Straight Thru Diodes
J, JTX, JTXV	**1N6101**	**J**	8 Straight Thru Diodes
J, JTX, JTXV	**1N6506**	**J**	8 Common Cathode Diode Array
J, JTX, JTXV	**1N6507**	**J**	8 Common Anode Diode Array
J, JTX, JTXV	**1N6508**	**J**	16 Diode Array
J, JTX, JTXV	**1N6509**	**J**	Dual 4 Common Anode, 4 Common Cathode
J, JTX, JTXV	**1N6510**	**F**	8 Straight Thru Diodes
J, JTX, JTXV	**1N6511**	**J**	7 Straight Thru Diodes

Notes

Thumb Index

12

LINFINITY MICROELECTRONICS

Discontinued Products

NOT RECOMMENDED FOR NEW DESIGNS, LIFETIME BUY AND OBSOLETE PRODUCTS

DESCRIPTION OF LISTINGS

General Information

As part of Linfinity's continuous effort to improve availability and lead times on products, we monitor each product's demand over time. If demand is weak on older products which are no longer being designed into systems, they are candidates for obsolescence. We understand this can cause problems for low-volume or spare parts types of usage. Consequently, it is our policy to notify users in advance of a product's potential obsolescence and clissify that product as (1) *Not Recommended for New Designs*, (2) *a Lifetime Buy Product* or (3) an *Obsolete Product*. Each of these categories is described below, followed by a table of Linfinity products which fall into the appropriate category at the time of the printing of this Databook. **NOTE: Because products on each of these lists are constantly changing, users are urged to contact Linfinity for the most up-to-date information on a product's status.**

Table 1 ---------▶ Not Recommended for New Designs

A product that is initially targeted for obsolescence is first categorized as *Not Recommended for New Designs* to alert designers that it should not be used in new product designs. The typical life-span of a product in this category is six (6) months. During this *Not Recommended for New Designs* period, Linfinity will accept all orders, but will urge users to avoid this product for designs under development. Once this 6-month period ends, a product will typically be moved into the *Lifetime Buy* category. Those products identified as candidates for the *Not Recommended for New Designs* status are candidates for obsolescence and may not necessarily be obsolete. Please contact Linfinity at the number listed below if you feel a particular product should not be made obsolete or if you need assistance finding a replacement product. Table 1 below lists products categorized as *Not Recommended for New Designs* at the time of this Databook's printing.

Table 2 --------------▶ Lifetime Buy Products

Products listed in the *Lifetime Buy* category are defined as products that are within 6 months of obsolescence. During this *Lifetime Buy* period, Linfinity will accept all orders, but the product is non-returnable. Once this 6-month period expires, Linfinity will not accept orders for these products unless inventory is available. Please contact Linfinity at the number listed below to place an order or to receive assistance in finding a replacement product. Table 2 below lists product in the *Lifetime Buy* category.

Table 3 ---------------▶ Obsolete Products

Products listed in the Obsolete category are no longer being manufactured by Linfinity. Orders are no longer accepted on these products. However, in some instances, Linfinity may have inventory available. In these isolated cases, we will accept orders but the product is non-returnable. Please contact us at the number listed below to check inventory on obsoleted products or if you need assistance in finding a replacement product. (See Table 3)

More Info... For information on Lifetime Buys or Obsolete Products, please follow these instructions:

1. Call 714-898-8121.
2. Identify your call as a *Discontinued Product Question*.
3. Please provide your *Company name* and *Location*.
4. The receptionist will forward your call to the appropriate Inside Sales Contact.

Table 1

NOT RECOMMENDED FOR NEW DESIGNS

Part No.	Description	Part No.	Description
LX1823	High-Speed Current-Mode PWM	**SG55470/1/2/3/4**	Dual Peripheral Positive Drivers
SG103-xx	Voltage Reference 1.8V - 5.1V	**SM600/1/2/10/11/12**	Switching Regulator Power Output Stages
SG120-xx	Neg. Fixed Voltage Reg. - 5.2,8,18,20,24V	**SM625/626/627**	Switching Regulator Power Output Stages
SG143/343	High Voltage Operational Amplifier	**SM645/646/647**	Switching Regulator Power Output Stages
SG140/A-xx	Pos. Fixed Voltage Reg. - 6,8,18,20,24V	**SG75450B/1/2/3/4**	Dual Peripheral Positive Drivers
SG1529/2529/3529	Voltage Mode Pulse Width Modulator	**SG75460/1/2/3/4**	Dual Peripheral Positive Drivers
SG1536/1436	High Voltage Operational Amplifier	**SG75470/1/2/3/4**	Dual Peripheral Positive Drivers
SG1540/2540/3540	Off-Line Start-Up Controller	**SG7806/A**	Positive Fixed Voltage Regulator - 6V
SG1635/3635	2A Half Bridge Driver	**SG7808/A**	Positive Fixed Voltage Regulator - 8V
SG1825C/2825C/3825C	High-Speed Current-Mode PWM	**SG7818/A**	Positive Fixed Voltage Regulator - 18V
SG3561A	Power Factor Contoller	**SG7820/A**	Positive Fixed Voltage Regulator - 20V
SG3645	Quad 2.5A Power Driver	**SG7824/A**	Positive Fixed Voltage Regulator - 24V
SG55236	Dual Sense Amplifier / Data Registers	**SG7905.2/A**	Negative Fixed Voltage Regulator - 5.2V
SG55325/75325	Dual Source / Dual Sink Memory Driver	**SG7908/A**	Negative Fixed Voltage Regulator - 8V
SG55326/74326	Quad Sink Memory Driver	**SG7918/A**	Negative Fixed Voltage Regulator - 18V
SG55327/75327	Quad Source Memory Driver	**SG7920/A**	Negative Fixed Voltage Regulator - 20V
SG55450B/1/2/3/4	Dual Peripheral Positive Drivers	**SG7924/A**	Negative Fixed Voltage Regulator - 24V
SG55460/1/2/3/4	Dual Peripheral Positive Drivers		

LINFINITY MICROELECTRONICS

Discontinued Products

NOT RECOMMENDED FOR NEW DESIGNS, LIFETIME BUY AND OBSOLETE PRODUCTS

Table 2

LIFETIME BUY REFERENCE

Part No.	Description	Planned Obsol. Date
SG103-xx	Voltage Reference	10-95
SG1540	Off-Line Start-Up Controller	10-95
SG3645	Quad 2.5A Power Driver	10-95

Table 3

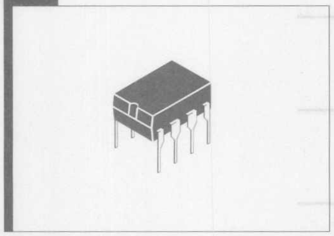
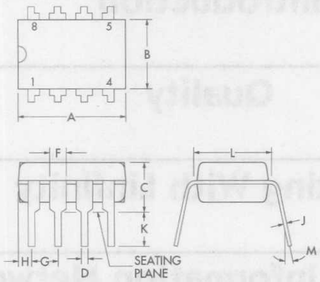
OBSOLETE PRODUCT REFERENCE

Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete
SG040	5/28/92	SG1568	5/28/92	SG238A	5/28/92	SG338	5/28/92	SG5524	5/28/92
SG101	5/28/92	SG1595	5/28/92	SG2401	5/28/92	SG338A	5/28/92	SG5534	5/28/92
SG101A	5/28/92	SG1596	5/28/92	SG2402	5/28/92	SG340	5/28/92	SG5768A	5/28/92
SG103-2.0	2/22/96	SG1627	5/28/92	SG250	5/28/92	SG3401	5/28/92	SG5770A	5/28/92
SG103-2.2	2/22/96	SG1629	5/28/92	SG2501A	5/28/92	SG3402	5/28/92	SG5772A	5/28/92
SG103-3.0	2/22/96	SG1635A	5/28/92	SG2502	5/28/92	SG3423	5/28/92	SG5774A	5/28/92
SG103-3.6	2/22/96	SG1650	5/28/92	SG250A	5/28/92	SG3423A	5/28/92	SG5792	5/28/92
SG103-3.9	2/22/96	SG1825	8/17/93	SG2528	5/28/92	SG343	10/1/94	SG5793	5/28/92
SG103-4.3	2/22/96	SG1840	5/28/92	SG2530	5/28/92	SG350	5/28/92	SM635	8/17/93
SG103-5.6	2/22/96	SG1847	5/28/92	SG2542	5/28/92	SG3501A	5/28/92	SM636	8/17/93
SG104	5/28/92	SG203	10/1/94	SG2557	5/28/92	SG3502	5/28/92	SM637	8/17/93
SG105	5/28/92	SG204	5/28/92	SG2559	11/15/95	SG350A	5/28/92	SM655	8/17/93
SG105A	5/28/92	SG205	5/28/92	SG2560	11/15/95	SG3523	5/28/92	SM656	8/17/93
SG107	5/28/92	SG205A	5/28/92	SG25768	5/28/92	SG3523A	5/28/92	SM657	8/17/93
SG111	5/28/92	SG2005	5/28/92	SG25770	5/28/92	SG3528	5/28/92	SM660	8/17/93
SG1173	8/17/93	SG2022	5/28/92	SG2805	10/1/94	SG3530	5/28/92	SM661	8/17/93
SG117AHV	5/28/92	SG2025	5/28/92	SG2822	10/1/94	SG3542	5/28/92	SM662	8/17/93
SG117HV	5/28/92	SG2064	5/28/92	SG2825	10/1/94	SG3557	5/28/92	SM670	8/17/93
SG124	5/28/92	SG2065	5/28/92	SG2840	5/28/92	SG3559	11/15/95	SM671	8/17/93
SG124A	5/28/92	SG2066	5/28/92	SG2847	5/28/92	SG3560	11/15/95	SM672	8/17/93
SG138	5/28/92	SG2067	5/28/92	SG301	5/28/92	SG3561	8/17/93	SG723C	5/28/92
SG138A	5/28/92	SG2068	5/28/92	SG301A	5/28/92	SG3627	5/28/92	SG741	5/28/92
SG1401	5/28/92	SG2069	5/28/92	SG303	10/1/94	SG3629	5/28/92	SG741C	5/28/92
SG1402	5/28/92	SG207	5/28/92	SG304	5/28/92	SG3635A	5/28/92	SG7805C	5/28/92
SG1468	5/28/92	SG2070	5/28/92	SG3045	5/28/92	SG3650	5/28/92	SG7806C	5/28/92
SG1488	5/28/92	SG2071	5/28/92	SG3046	5/28/92	SG3663	5/28/92	SG7808C	5/28/92
SG1489	5/28/92	SG2074	10/1/94	SG3049	5/28/92	SG3700	5/28/92	SG7812C	5/28/92
SG1489A	5/28/92	SG2075	10/1/94	SG305	5/28/92	SG3718	6/10/95	SG7815C	5/28/92
SG1495	5/28/92	SG2076	5/28/92	SG305A	5/28/92	SG3821	5/28/92	SG7818C	5/28/92
SG1496	5/28/92	SG2077	5/28/92	SG3086	5/28/92	SG3825	5/28/92	SG7820C	5/28/92
SG150	5/28/92	SG2101A	5/28/92	SG311	5/28/92	SG3840	5/28/92	SG7824C	5/28/92
SG1501A	8/17/93	SG211	5/28/92	SG3172	8/17/93	SG3847	5/28/92	SG7905C	5/28/92
SG1502	5/28/92	SG2111	5/28/92	SG3173	5/28/92	SG4501	5/28/92	SG7906C	5/28/92
SG150A	5/28/92	SG2172	5/28/92	SG317AHV	5/28/92	SG508	5/28/92	SG7908C	5/28/92
SG1528	5/28/92	SG2173	5/28/92	SG317HV	5/28/92	SG510A4	8/17/93	SG7912C	5/28/92
SG1530	5/28/92	SG217HV	5/28/92	SG3183	5/28/92	SG510AR4	8/17/93	SG7915C	5/28/92
SG1542	5/28/92	SG217AHV	5/28/92	SG320	5/28/92	SG541	8/17/93	SG7918C	5/28/92
SG1557	5/28/92	SG224	5/28/92	SG3212	5/28/92	SG55234	5/28/92	SG7920C	5/28/92
SG1559	5/28/92	SG224A	5/28/92	SG324	5/28/92	SG55234A	5/28/92	SG7924C	5/28/92
SG1560	5/28/92	SG238	5/28/92	SG324A	5/28/92	SG55236A	5/28/92		

LINFINITY MICROELECTRONICS

LINFINITY MICROELECTRONICS

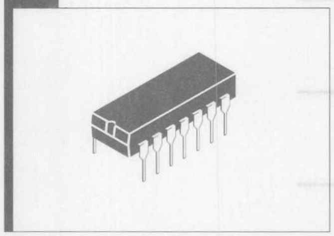
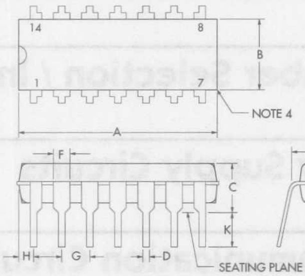
M 8-Pin Plastic Mini-Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	10.16	—	0.400
B	6.10	6.60	0.240	0.260
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°

* See NOTE: 1

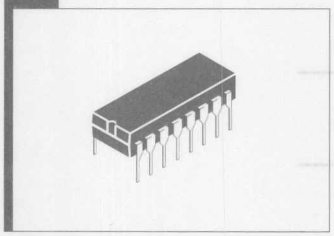
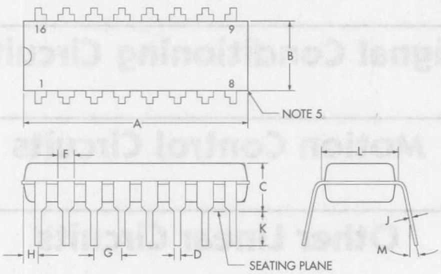
N 14-Pin Plastic Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.54	20.57	0.730	0.810
B	6.09	6.60	0.240	0.260
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	1.27	2.28	0.050	0.090
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°

* See NOTE: 1

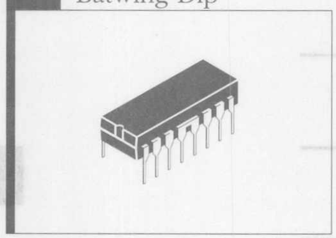
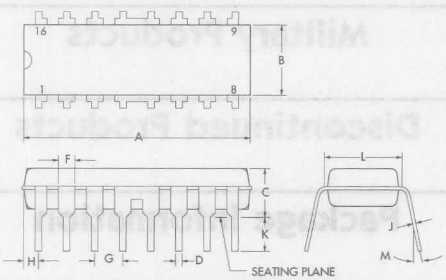
N 16-Pin Plastic Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.54	20.57	0.730	0.810
B	6.10	6.60	0.240	0.260
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.78	0.030	0.070
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°

* See NOTE: 1

W 16-Pin Plastic Batwing Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.54	20.57	0.730	0.810
B	6.10	6.60	0.240	0.260
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	0.64	1.78	0.025	0.070
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°

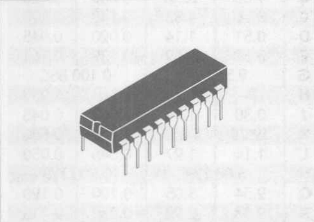
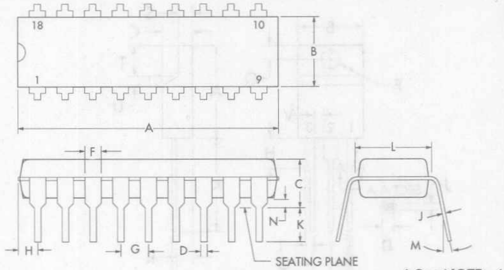
* See NOTE: 1

* All Notes are located at the end of the Package Outline Section — Page 13-17

Package Information

Mechanical Dimensions

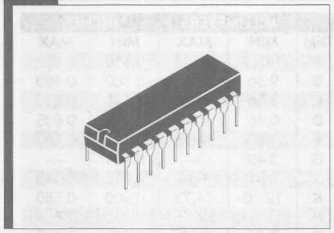
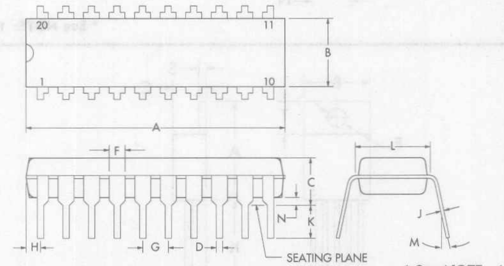
N 18-Pin Plastic Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.61	23.11	0.890	0.910
B	6.10	6.60	0.240	0.260
C	3.56	5.08	0.140	0.200
D	0.381	0.508	0.015	0.020
F	0.76	1.78	0.030	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.381	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°
N	0.38	0.64	0.015	0.025

* See NOTE: 1

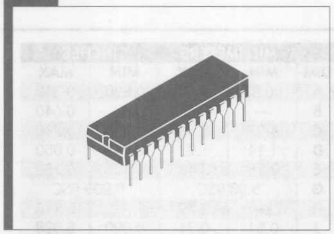
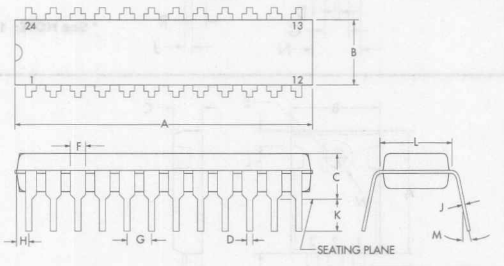
N 20-Pin Plastic Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	25.91	26.42	1.020	1.040
B	6.10	6.60	0.240	0.260
C	3.56	4.57	0.140	0.180
D	0.38	0.53	0.015	0.021
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°
N	0.38	0.89	0.015	0.035

* See NOTE: 1

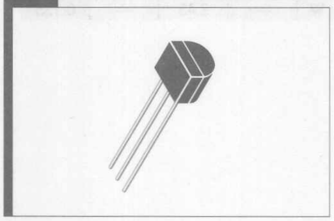
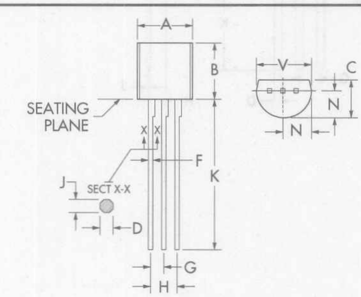
N 24-Pin Plastic Dip

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	29.21	29.85	1.150	1.175
B	6.10	6.86	0.240	0.270
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.52	0.030	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.52	0.030	0.060
J	0.20	0.38	0.008	0.015
K	3.18	—	0.125	—
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°
P	6.35	6.60	0.250	0.260

* See NOTE: 1

LP 3-Pin TO-92

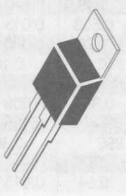
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.45	5.20	0.175	0.205
B	4.32	5.33	0.170	0.210
C	3.18	4.19	0.125	0.165
D	0.41	0.55	—	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	2.42	2.66	0.095	0.105
J	0.39	0.50	0.015	0.020
K	12.70	—	0.500	—
N	2.05	2.66	0.080	0.105
V	3.43	—	0.135	—

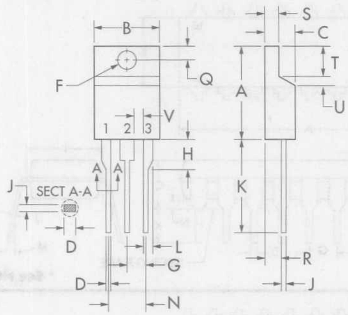
* All Notes are located at the end of the Package Outline Section — Page 13-17

Package Information

MECHANICAL DIMENSIONS

P 3-Pin Plastic TO-220

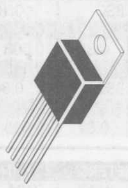


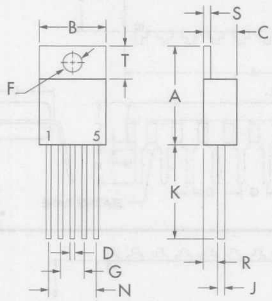


* See NOTE: 1

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.22	15.88	0.560	0.625
B	9.65	10.67	0.380	0.420
C	3.56	4.83	0.140	0.190
D	0.51	1.14	0.020	0.045
F	3.53	4.09	0.139	0.161
G	2.54 BSC		0.100 BSC	
H	—	6.35	—	0.250
J	0.30	1.14	0.012	0.045
K	12.70	14.73	0.500	0.580
L	1.14	1.27	0.045	0.050
N	5.08 TYP		0.200 TYP	
Q	2.54	3.05	0.100	0.120
R	2.03	2.92	0.080	0.115
S	1.14	1.40	0.045	0.055
T	5.84	6.86	0.230	0.270
U	0.508	1.14	0.020	0.045

P 5-Pin Plastic TO-220

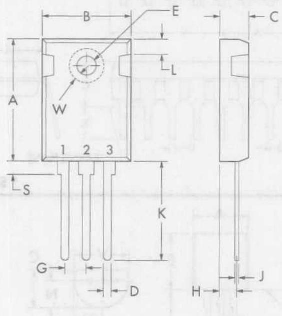




* See NOTE: 1

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.23	16.51	0.560	0.650
B	9.66	10.66	0.380	0.420
C	3.56	4.82	0.140	0.190
D	0.46	0.89	0.018	0.035
F	3.56	4.06	0.140	0.160
G	3.40	—	0.134	—
J	0.31	1.14	0.012	0.045
K	12.70	14.73	0.500	0.580
N	6.80 TYP		0.268 TYP	
R	2.04	2.92	0.080	0.115
S	1.14	1.39	0.045	0.055
T	5.85	6.85	0.230	0.270

V 3-Pin Plastic TO-247

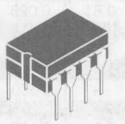


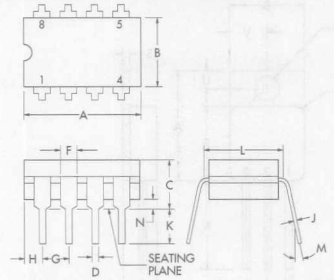
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.83	21.34	0.820	0.840
B	—	16.26	—	0.640
C	4.93	5.33	0.190	0.210
D	1.14	1.27	0.045	0.050
E	3.18	3.43	0.125	0.135
G	5.08 BSC		0.200 BSC	
H	—	2.79	—	0.110
J	0.51	0.71	0.020	0.028
K	12.70	20.07	0.500	0.790
L	3.05	3.56	0.120	0.140
S	3.81	4.32	0.150	0.170
W	—	3.43	—	0.135

* All Notes are located at the end of the Package Outline Section — Page 13-17

LINFINITY MICROELECTRONICS

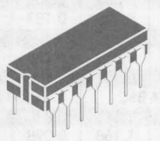
Y 8-Pin Ceramic Mini-Dip

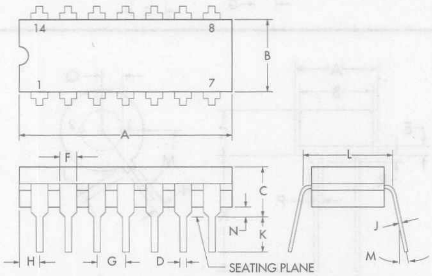




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.91	10.92	0.390	0.430
B	5.59	7.11	0.220	0.280
C	4.32	5.08	0.170	0.200
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54 TYP		0.100 TYP	
H	1.14	1.65	0.045	0.065
J	0.20	0.38	0.008	0.015
K	3.18	4.06	0.125	0.160
L	7.37	7.87	0.290	0.310
M	—	15°	—	15°
N	0.51	1.02	0.020	0.040

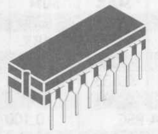
J 14-Pin Ceramic Dip

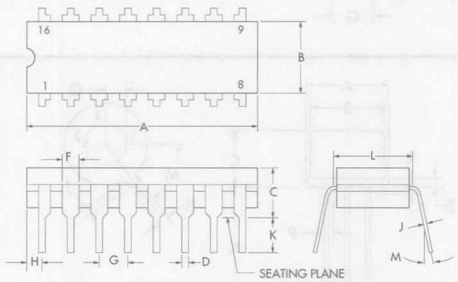




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	19.30	19.94	0.760	0.785
B	5.59	7.11	0.220	0.280
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	1.02	1.77	0.040	0.070
G	2.54 TYP		0.100 TYP	
H	—	2.03	—	0.080
J	0.20	0.38	0.008	0.015
K	3.17	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M	—	15°	—	15°
N	0.51	0.76	0.020	0.030

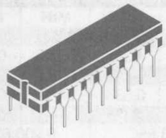
J 16-Pin Ceramic Dip

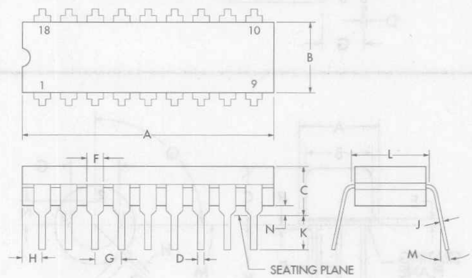




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	19.30	19.94	0.760	0.785
B	5.59	7.11	0.220	0.280
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.77	0.030	0.070
G	2.54 TYP		0.100 TYP	
H	—	2.03	—	0.080
J	0.20	0.38	0.008	0.015
K	3.18	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M	—	15°	—	15°
N	0.51	0.76	0.020	0.030

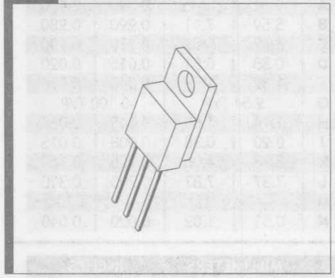
J 18-Pin Ceramic Dip

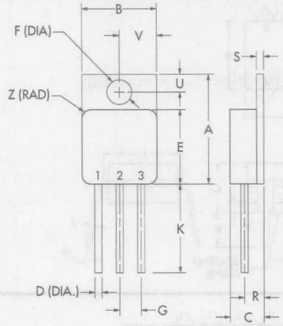




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	24.38	—	0.960
B	5.59	7.11	0.220	0.280
C	—	5.08	—	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.78	0.030	0.070
G	2.54 TYP		0.100 TYP	
H	—	2.03	—	0.080
J	0.20	0.38	0.008	0.015
K	3.18	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M	—	15°	—	15°
N	0.51	0.76	0.020	0.030

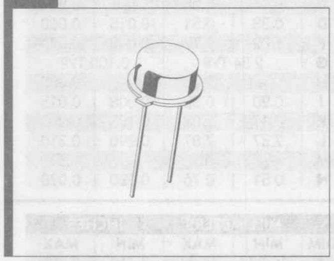
IG 3-Pin Hermetic TO-257 (Isolated)

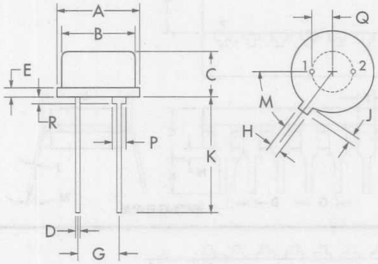




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	16.38	16.64	0.645	0.655
B	10.41	10.67	0.410	0.420
C	4.70	4.95	0.185	0.195
D	0.71	0.81	0.028	0.032
E	10.41	10.67	0.410	0.420
F	3.56	3.81	0.140	0.150
G	2.54 TYP		0.100 TYP	
K	12.70	—	0.500	—
N	5.08 TYP		0.200 TYP	
R	2.92	3.18	0.115	0.125
S	0.89	1.43	0.035	0.045
U	2.87	3.12	0.113	0.123
V	5.13	5.38	0.202	0.212
Z	1.40 TYP		0.055 TYP	

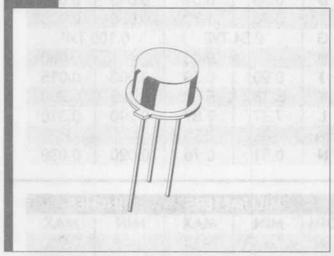
Z 2-Pin Metal Can TO-46

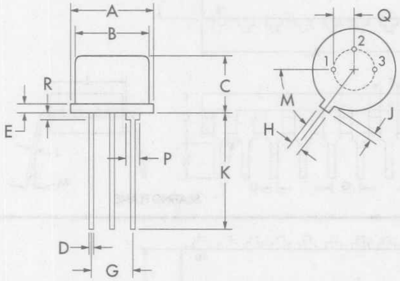




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.308	5.588	0.209	0.220
B	4.648	5.029	0.183	0.198
C	—	2.667	—	0.105
D	0.406	0.533	0.016	0.021
E	—	0.381	—	0.015
G	2.54 BSC		0.100 BSC	
H	0.914	1.143	0.036	0.045
J	0.711	1.168	0.028	0.046
K	12.70	—	0.500	—
M	42°	48°	42°	48°
P	—	1.19	—	0.047
Q	1.27 TYP		0.050 TYP	
R	—	0.381	—	0.015

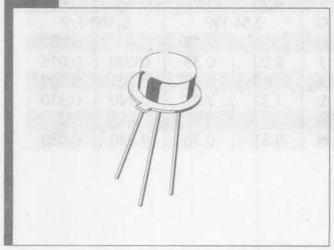
Z 3-Pin Metal Can TO-52

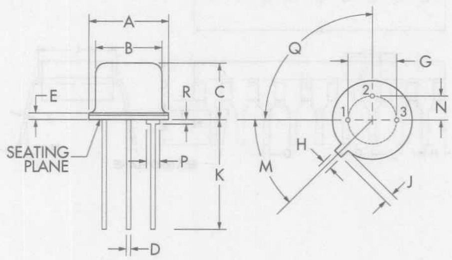




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.308	5.588	0.209	0.220
B	4.648	5.029	0.183	0.198
C	—	4.064	—	0.160
D	0.406	0.533	0.016	0.021
E	—	0.381	—	0.015
G	2.54 BSC		0.100 BSC	
H	0.914	1.143	0.036	0.045
J	0.711	1.168	0.028	0.046
K	12.70	—	0.500	—
M	42°	48°	42°	48°
P	—	1.193	—	0.047
Q	1.27 TYP		0.050 TYP	
R	—	0.381	—	0.015

T 3-Pin Metal Can TO-39

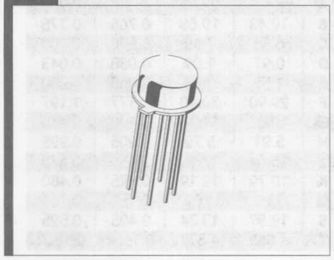


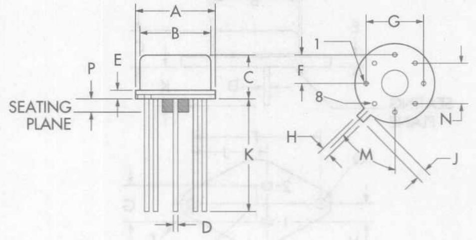


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.13	8.51	0.320	0.335
C	4.19	4.70	0.165	0.185
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
G	5.08 BSC		0.200 BSC	
H	0.711	0.864	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	14.48	0.500	0.570
M	45° TYP		45° TYP	
N	2.54 TYP		0.100 TYP	
P	—	1.143	—	0.045
Q	90° TYP		90° TYP	
R	—	0.635	—	0.025

LINFINITY MICROELECTRONICS

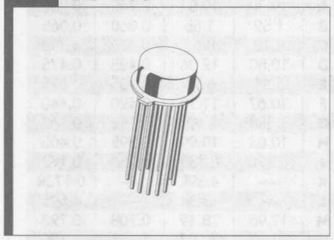
T 8-Pin Metal Can TO-99

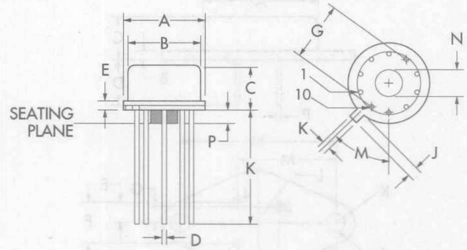




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	—	1.016	—	0.040
F	2.54 TYP		0.100 TYP	
G	5.08 TYP		0.200 TYP	
H	0.711	0.864	0.028	0.034
J	0.737	1.14	0.029	0.045
K	12.70	14.48	0.500	0.570
M	45° TYP		45° TYP	
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040

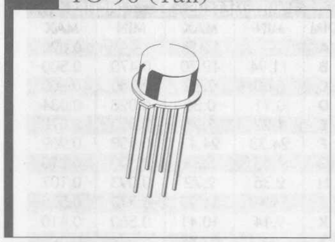
T 10-Pin Metal Can TO-100

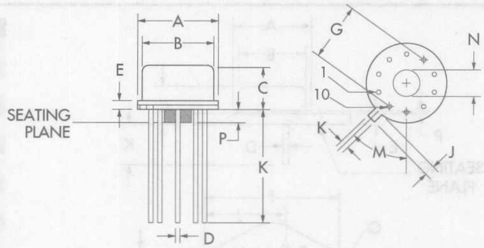




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.890	9.398	0.350	0.370
B	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	—	1.016	—	0.040
G	5.842 TYP		0.230 TYP	
H	0.711	0.864	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36° TYP		36° TYP	
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040

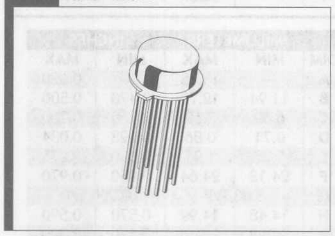
T 10-Pin Metal Can TO-96 (Tall)

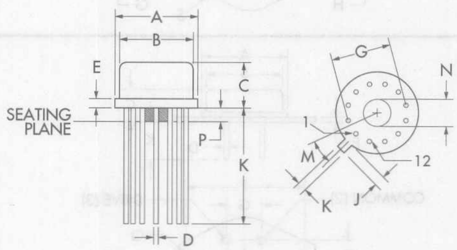




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.890	9.398	0.350	0.370
B	8.00	8.51	0.315	0.335
C	6.096	6.604	0.240	0.260
D	0.406	0.533	0.016	0.021
E	—	1.016	—	0.040
G	5.842 TYP		0.230 TYP	
H	0.711	0.636	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36° TYP		36° TYP	
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040

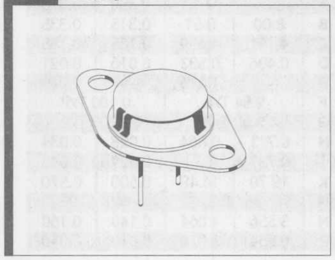
T 12-Pin Metal Can TO-101

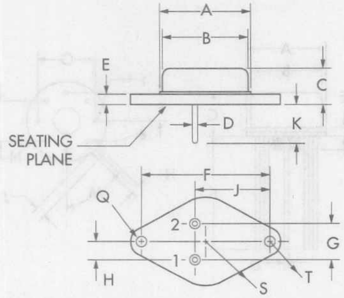




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.89	9.40	0.350	0.370
B	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	—	1.016	—	0.040
G	5.842 TYP		0.230 TYP	
H	0.711	0.864	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36° TYP		36° TYP	
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040

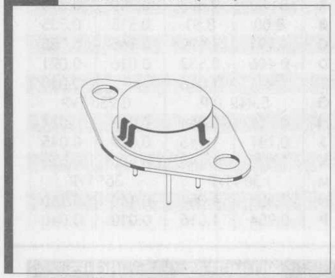
K 3-Terminal Metal Can TO-3

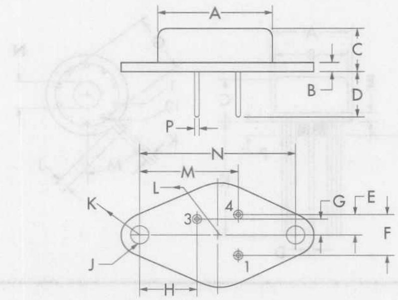




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	23.62	—	0.930
B	19.43	19.68	0.765	0.775
C	6.86	7.62	0.270	0.300
D	0.97	1.09	0.038	0.043
E	1.52	2.03	0.060	0.080
F	29.90	30.40	1.177	1.197
G	10.67	11.18	0.420	0.440
H	5.21	5.72	0.205	0.225
J	16.64	17.14	0.655	0.675
K	10.79	12.19	0.425	0.480
Q	3.84	4.09	0.151	0.161
S	12.57	13.34	0.495	0.525
T	4.06R	4.57R	0.160R	0.180R

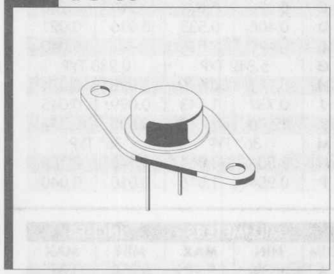
K 4-Terminal Hybrid Metal Can (SM)

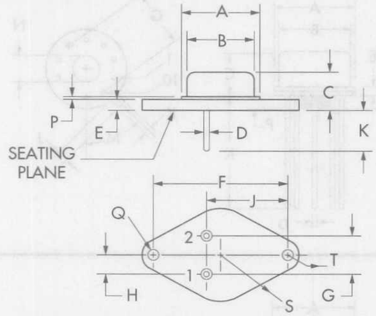




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	19.30	19.81	0.760	0.780
B	1.52	1.65	0.060	0.065
C	8.12	8.63	0.320	0.340
D	10.80	12.06	0.425	0.475
E	5.21	5.72	0.205	0.225
F	10.67	11.18	0.420	0.440
G	3.680	4.190	0.145	0.165
H	10.03	10.29	0.395	0.405
J	0.396	0.439	0.156	0.173
K	—	4.39R	—	0.173R
L	—	13.34	—	0.525
M	17.98	18.49	0.708	0.728
N	30.07	30.23	1.184	1.190
P	0.970	1.090	0.038	0.043

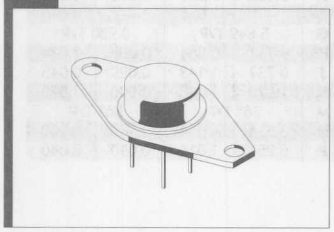
R 3-Terminal Metal Can TO-66

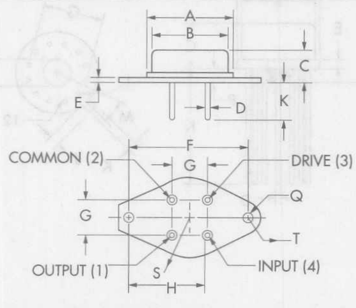




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	15.75	—	0.620
B	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.91	0.050	0.075
F	24.33	24.43	0.958	0.962
G	4.83	5.33	0.190	0.210
H	2.36	2.72	0.093	0.107
J	14.48	14.99	0.570	0.590
K	9.14	10.41	0.360	0.410
P	—	0.635	—	0.025
Q	3.61	3.86	0.142	0.152
S	—	8.89R	—	0.350R
T	—	3.68R	—	0.145R

R 4-Pin Metal Can (SM)

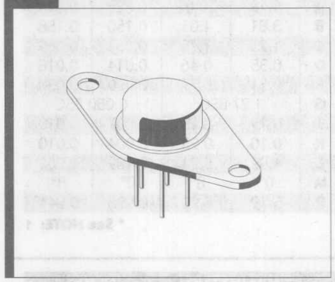


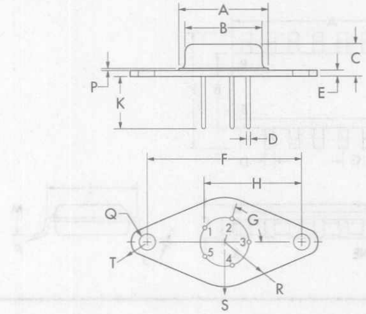


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	15.75	—	0.620
B	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.91	0.050	0.075
F	24.13	24.64	0.950	0.970
G	5.08 TYP		0.200 TYP	
H	14.48	14.99	0.570	0.590
K	9.398	9.906	0.370	0.390
Q	3.607	3.861	0.142	0.152
S	—	8.89R	—	0.350R
T	—	3.55R	—	0.140R

LINFINITY MICROELECTRONICS

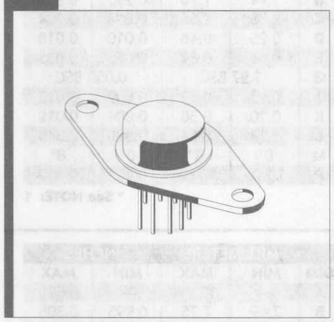
R 5-Pin Metal Can TO-66

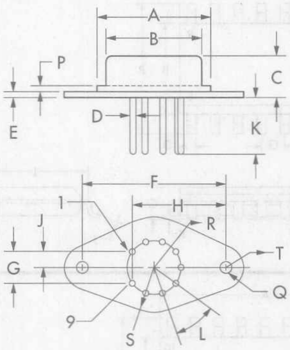




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	15.75	—	0.620
B	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.90	0.050	0.075
F	24.33	24.43	0.958	0.962
G	72° TYP		72° TYP	
H	14.48	14.99	0.570	0.590
K	9.14	10.41	0.360	0.410
P	—	0.635	—	0.025
Q	3.607	3.861	0.142	0.152
R	—	4.11R	—	0.162R
S	—	8.89R	—	0.350R
T	—	3.55R	—	0.140R

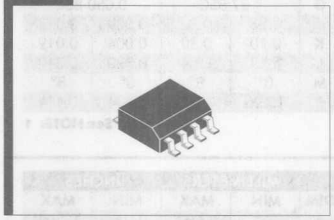
R 9-Pin Metal Can TO-66

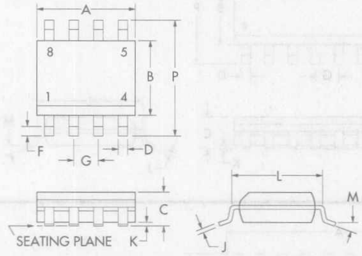




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	15.75	—	0.620
B	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.270	1.905	0.050	0.075
F	24.33	24.43	0.958	0.962
G	4.826	5.334	0.190	0.590
H	14.48	14.99	0.570	0.590
J	2.362	2.718	0.093	0.107
K	9.14	10.41	0.360	0.410
L	36° TYP		36° TYP	
P	—	0.635	—	0.025
Q	3.607	3.861	0.142	0.152
R	—	4.11R	—	0.162R
S	—	8.89R	—	0.350R
T	—	3.683R	—	0.145R

DM 8-Pin Plastic S.O.I.C.

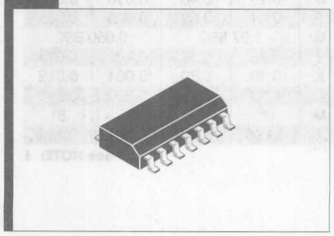


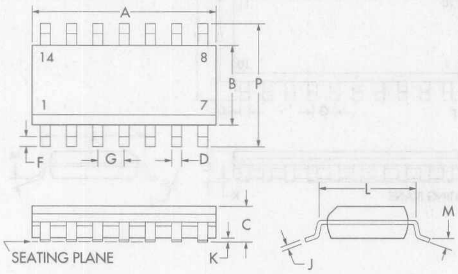


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.65	5.13	0.183	0.202
B	3.66	4.14	0.144	0.163
C	1.73	1.88	0.068	0.074
D	0.25	0.51	0.010	0.020
F	0.38	0.89	0.015	0.035
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.13	0.25	0.005	0.010
L	4.80	5.21	0.189	0.205
M	—	8°	—	8°
P	5.79	6.20	0.228	0.244

* See NOTE: 1

D 14-Pin Plastic S.O.I.C.



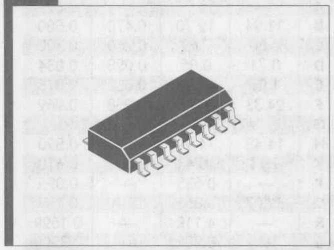


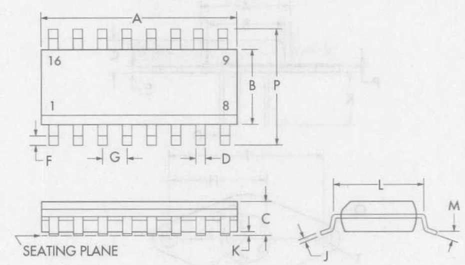
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.54	8.74	0.336	0.344
B	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.67	0.77	0.026	0.030
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244

* See NOTE: 1

* All Notes are located at the end of the Package Outline Section — Page 13-17

D 16-Pin Plastic S.O.I.C.

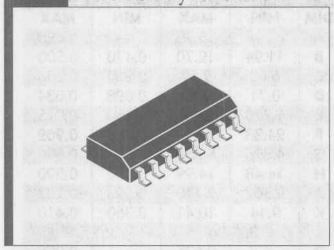


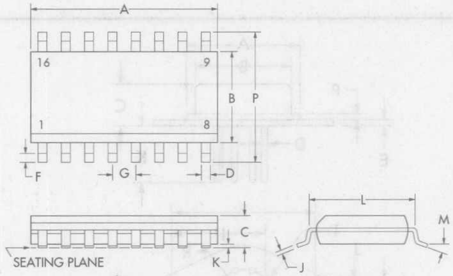


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.78	10.01	0.385	0.394
B	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.51	0.77	0.020	0.030
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244

* See NOTE: 1

DW 16-Pin Plastic (SOWB) Widebody S.O.I.C.

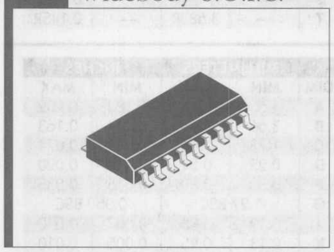


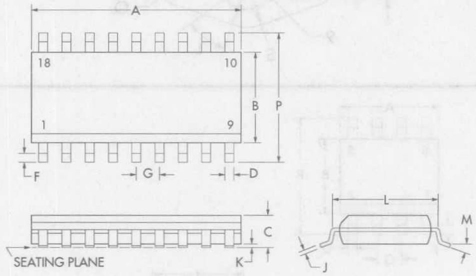


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	10.67	—	0.420
B	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

* See NOTE: 1

DW 18-Pin Plastic (SOWB) Widebody S.O.I.C.

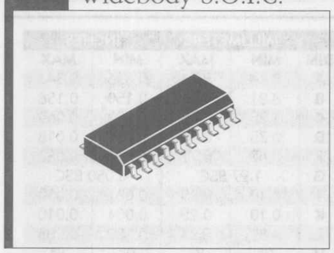


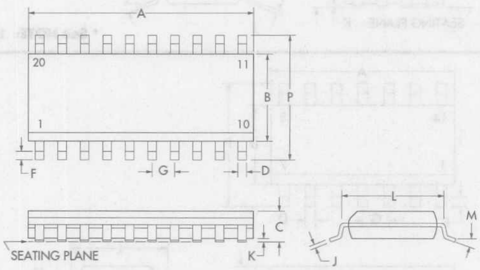


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	13.21	—	0.520
B	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

* See NOTE: 1

DW 20-Pin Plastic (SOWB) Widebody S.O.I.C.



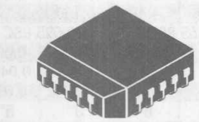


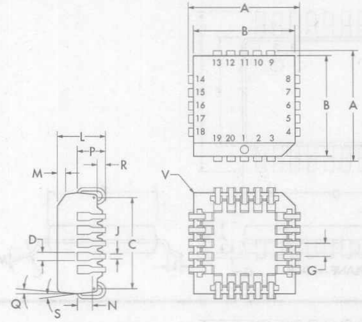
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	13.21	—	0.520
B	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

* See NOTE: 1

* All Notes are located at the end of the Package Outline Section — Page 13-17

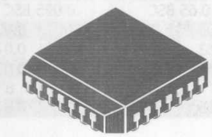
Q 20-Pin Plastic Leaded Chip Carrier (PLCC)

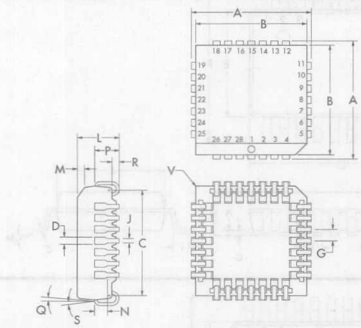




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.70	10.03	0.382	0.395
B	8.89	9.04	0.350	0.356
C	7.37	8.38	0.290	0.330
D	0.66	0.81	0.026	0.032
G	1.27 TYP		0.050 TYP	
J	0.33	0.53	0.013	0.021
L	4.06	4.78	0.160	0.188
M	1.27 TYP		0.050 TYP	
N	1.52	—	0.060	—
P	2.41	—	0.095	—
Q	3°		3°	
R	0.63	1.14	0.025	0.045
S	3°		3°	
V	—	0.51	—	0.020

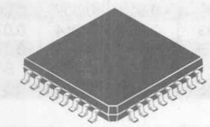
Q 28-Pin Plastic Leaded Chip Carrier (PLCC)

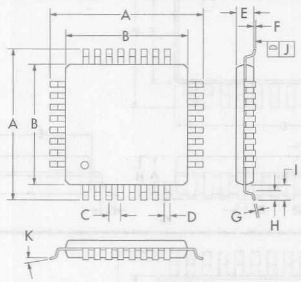




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	12.19	12.70	0.480	0.500
B	11.43	11.56	0.450	0.455
C	10.54	10.92	0.415	0.430
D	0.64	0.89	0.025	0.035
G	1.27 TYP		0.050 TYP	
J	0.33	0.53	0.013	0.021
L	4.06	4.83	0.160	0.190
M	1.14	—	0.045	—
N	0.76	1.27	0.030	0.050
P	2.41	—	0.095	—
Q	3°	6°	3°	6°
R	0.63	1.14	0.025	0.045
S	3°	6°	3°	6°
V	—	0.51	—	0.020

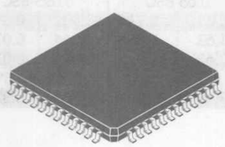
TF 32-Pin Thin Quad Flat Pack (TQFP)

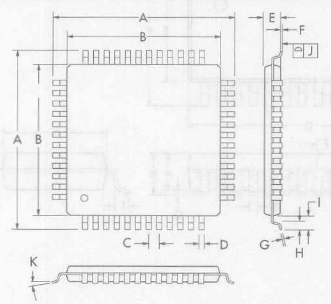




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.90	9.10	0.350	0.358
B	6.90	7.10	0.272	0.280
C	0.80 TYP		0.031 TYP	
D	0.30	0.45	0.012	0.018
E	1.35	1.45	0.053	0.057
F	0.05	0.15	0.002	0.006
G	0.090	0.200	0.004	0.008
H	0.45	0.75	0.018	0.030
I	1.00 TYP		0.039 TYP	
J	—	0.08	—	0.003
K	0°	7°	0°	7°

TF 48-Pin Thin Quad Flat Pack (TQFP)



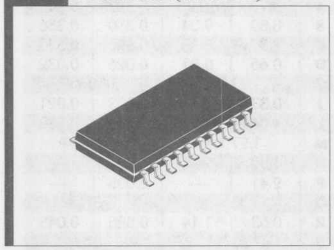


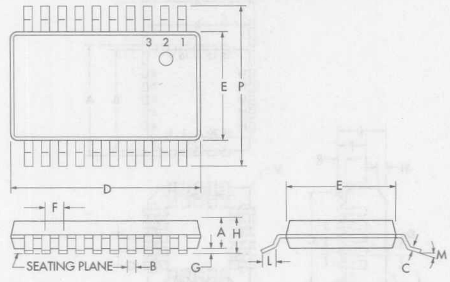
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.90	9.10	0.350	0.358
B	6.90	7.10	0.272	0.280
C	0.50 TYP		0.020 TYP	
D	0.17	0.27	0.007	0.012
E	1.35	1.45	0.053	0.057
F	0.05	0.15	0.002	0.006
G	0.090	0.200	0.004	0.008
H	0.45	0.75	0.018	0.030
I	1.00 TYP		0.039 TYP	
J	—	0.08	—	0.003
K	0°	7°	0°	7°

Package Information

MECHANICAL DIMENSIONS

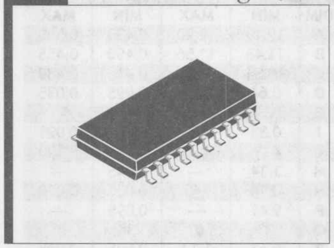
PW 20-Pin Thin Small Shrink Outline (TSSOP)

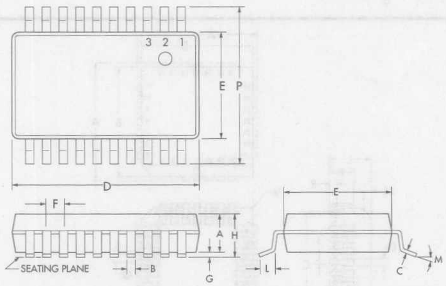




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	0.90	—	0.354
B	0.18	0.30	0.0071	0.0118
C	0.90	0.180	0.0035	0.0071
D	6.40	6.60	0.252	0.260
E	4.30	4.48	0.169	0.176
F	0.65 BSC		0.025 BSC	
G	0.05	0.15	0.002	0.005
H	—	1.10	—	0.0433
L	0.50	0.70	0.020	0.028
M	0°	8°	0°	8°
P	6.25	6.50	0.246	0.256

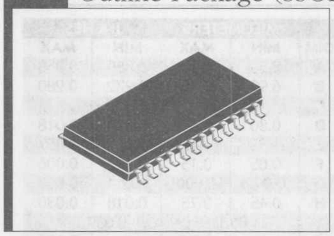
DB 20-Pin Shrink Small Outline Package (SSOP)

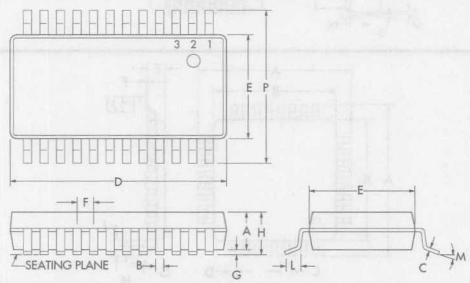




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.73	1.99	0.068	0.078
B	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	7.07	7.33	0.278	0.288
E	5.20	5.38	0.205	0.212
F	0.65 BSC		0.025 BSC	
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311

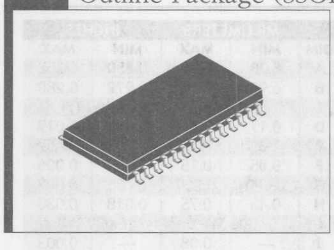
DB 24-Pin Shrink Small Outline Package (SSOP)

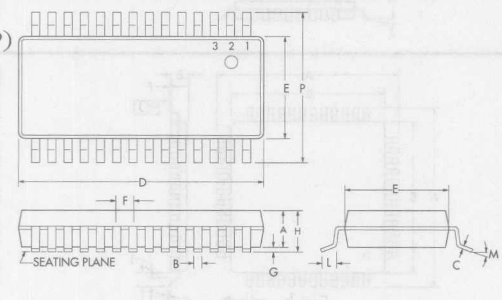




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.73	1.99	0.068	0.078
B	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	8.07	8.33	0.318	0.328
E	5.20	5.38	0.205	0.212
F	0.65 BSC		0.025 BSC	
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311

DB 28-Pin Shrink Small Outline Package (SSOP)





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.73	1.99	0.068	0.078
B	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	10.07	10.33	0.396	0.407
E	5.20	5.38	0.205	0.212
F	0.65 BSC		0.025 BSC	
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311

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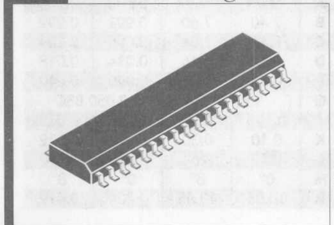
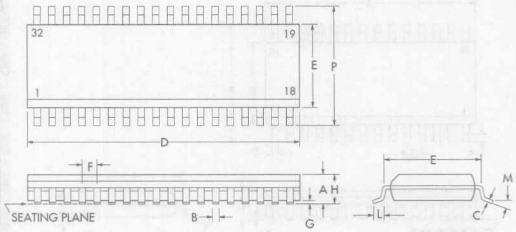
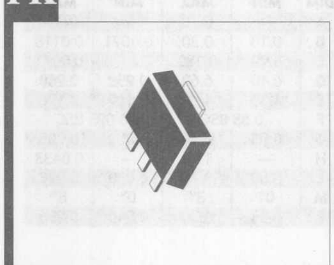
DB 36-Pin Shrink Small Outline Package (SSOP)

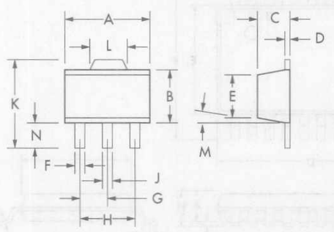




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.31	—	0.091	—
B	0.29	0.39	0.011	0.015
C	0.23	0.32	0.0091	0.0125
D	15.20	15.40	0.598	0.606
E	7.40	7.60	0.291	0.299
F	0.80 BSC		0.031 BSC	
G	0.13	—	0.005	—
H	2.44	2.64	0.096	0.104
L	0.51	1.01	0.020	0.040
M	0°	8°	0°	8°
P	10.11	10.51	0.398	0.414

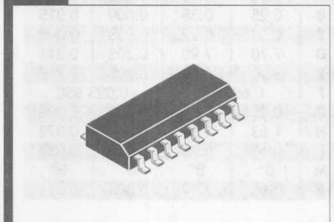
PK 3-Pin SOT-89

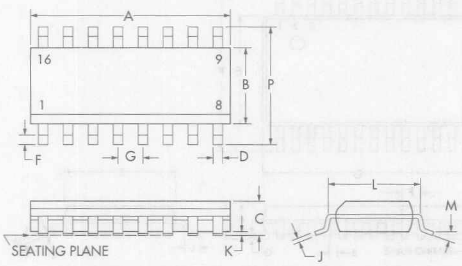




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.39	4.59	0.173	0.181
B	2.28	2.59	0.090	0.102
C	1.39	1.60	0.055	0.063
D	0.38	0.43	0.015	0.017
E	2.13	2.28	0.084	0.090
F	0.33	0.48	0.016	0.019
G	1.49 BSC		0.059 BSC	
H	2.99 BSC		0.118 BSC	
J	0.45	0.55	0.018	0.022
K	3.94	4.24	0.155	0.167
L	1.70	1.82	0.067	0.072
M	0°	8°	0°	8°
N	0.89	1.19	0.035	0.047

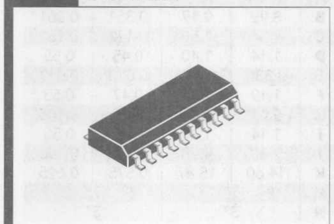
DP 16-Pin Plastic SOIC POWER

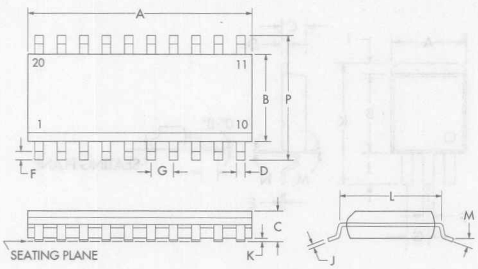




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.78	10.01	0.385	0.394
B	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.51	0.77	0.020	0.030
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244

DWP 20-Pin Plastic SOWB POWER



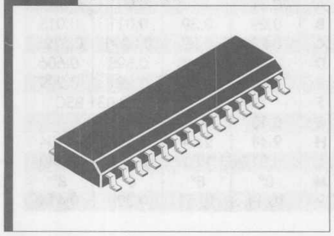


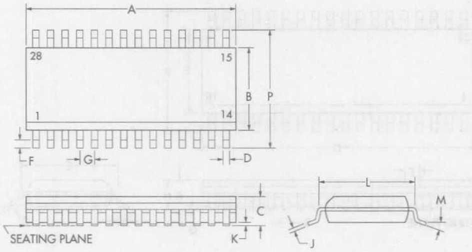
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	13.21	—	0.520
B	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

Package Information

MECHANICAL DIMENSIONS

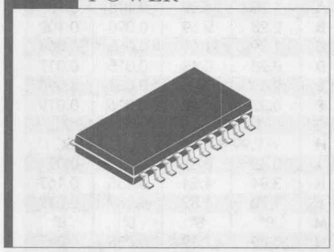
DWP 28-Pin Plastic SOWB POWER

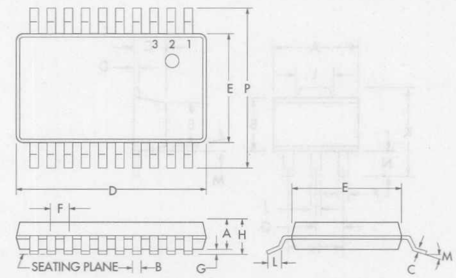




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	17.73	17.93	0.698	0.705
B	7.40	7.60	0.291	0.299
C	2.44	2.64	0.096	0.104
D	0.36	0.46	0.014	0.018
F	0.51	1.01	0.020	0.040
G	1.27 BSC		0.050 BSC	
J	0.123	0.32	0.005	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.390
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

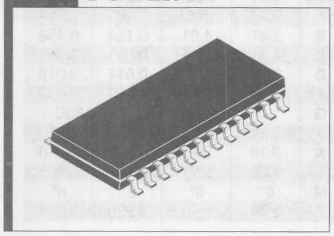
PWP 20-Pin TSSOP POWER

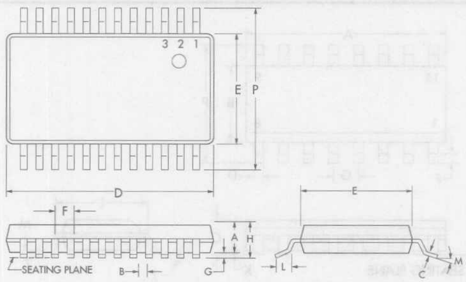




DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	0.90	—	0.354
B	0.18	0.30	0.0071	0.0118
C	0.90	0.180	0.0035	0.0071
D	6.40	6.60	0.252	0.260
E	4.30	4.48	0.169	0.176
F	0.65 BSC		0.025 BSC	
G	0.05	0.15	0.002	0.005
H	—	1.10	—	0.0433
L	0.50	0.70	0.020	0.028
M	0°	8°	0°	8°
P	6.25	6.50	0.246	0.256

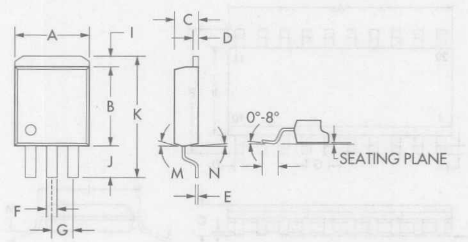
PWP 24-Pin TSSOP POWER





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.73	1.99	0.068	0.078
B	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	7.70	7.90	0.303	0.311
E	5.20	5.38	0.205	0.212
F	0.65 BSC		0.025 BSC	
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311

DD 3-Pin Plastic TO-263AA Surface Mount



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.41	10.67	0.410	0.420
B	8.92	9.17	0.351	0.361
C	4.34	4.59	0.171	0.181
D	1.14	1.40	0.45	0.55
E	0.330	0.432	0.013	0.017
F	1.19	1.34	0.47	0.53
G	2.41	2.66	0.95	0.105
I	1.14	1.40	0.45	0.55
J	2.33	4.98	0.192	0.196
K	14.60	15.87	0.575	0.625
M	7°		7°	
N	3°		3°	

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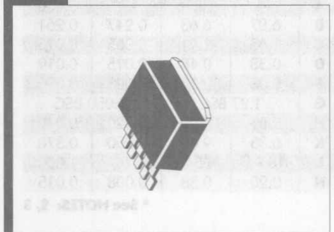
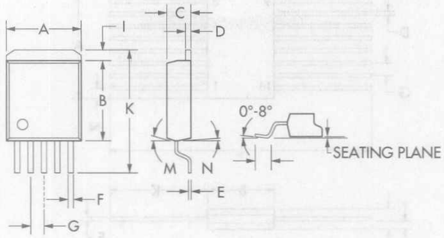
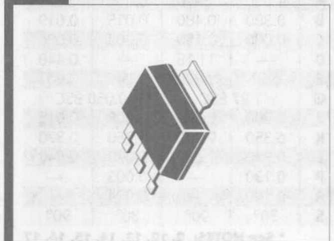
DD 5-Pin Plastic TO-263 Surface Mount

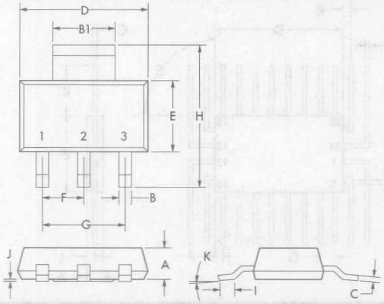




	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	10.16	10.67	0.400	0.420
B	8.92	9.17	0.351	0.361
C	4.34	4.59	0.171	0.181
D	1.14	1.40	0.45	0.55
E	0.330	0.432	0.013	0.017
F	0.737	0.889	0.029	0.035
G	1.57	1.83	0.062	0.072
I	1.14	1.40	0.45	0.55
K	14.60	15.87	0.575	0.625
M	7°		7°	
N	3°		3°	

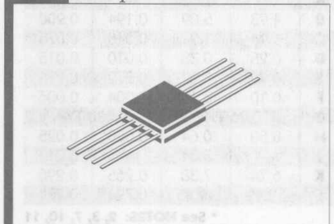
ST 3-pin SOT-223

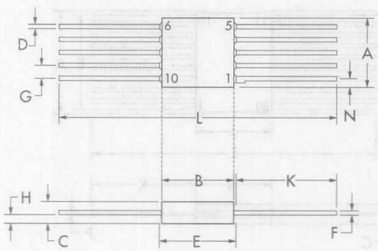




	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	1.55	1.80	0.061	0.071
B	0.65	0.85	0.026	0.033
B1	2.95	3.15	0.116	0.124
C	0.25	0.35	0.010	0.014
D	6.30	6.70	0.248	0.264
E	3.30	3.70	0.130	0.146
F	0.230 BSC		0.0905 BSC	
G	4.60 BSC		0.181 BSC	
H	6.71	7.29	0.264	0.287
I	—	0.91	—	0.36
J	0.02	0.10	0.0008	0.004
K	10° MAX		10° MAX	

F 10-Pin Ceramic Flatpack

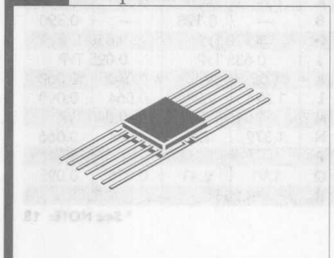


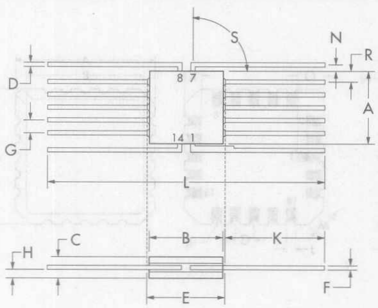


	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	—	7.37	—	0.290
B	6.04	6.40	0.238	0.252
C	1.45	1.70	0.057	0.067
D	0.25	0.483	0.010	0.019
E	—	6.91	—	0.272
F	0.076	0.153	0.003	0.006
G	1.27 TYP		0.050 TYP	
H	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	18.74	25.4	0.738	1.000
N	0.20	0.38	0.008	0.015

* See NOTES: 2, 3, 4

F 14-Pin Ceramic Flatpack

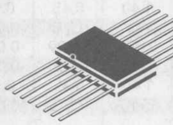


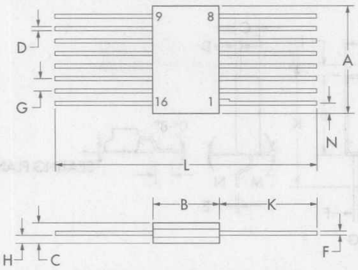


	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	—	7.11	—	0.280
B	6.10	6.40	0.240	0.252
C	1.45	1.70	0.057	0.067
D	0.25	0.483	0.010	0.019
E	—	6.91	—	0.272
F	0.08	0.15	0.003	0.006
G	1.27 TYP		0.050 TYP	
H	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	19.0	25.4	0.75	1.000
N	0.10	—	0.004	—
R	0.13	—	0.005	—
S	30°	90°	30°	90°

* See NOTES: 2, 5, 6, 7, 8, 9

F 18-Pin Ceramic Flatpack

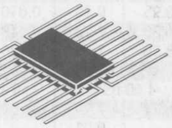


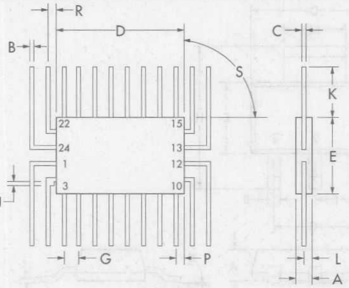


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES* MIN	INCHES* MAX
A	—	10.16	—	0.400
B	6.27	6.63	0.247	0.261
C	1.65	1.91	0.065	0.075
D	0.38	0.48	0.015	0.019
F	0.08	0.15	0.003	0.006
G	1.27 BSC		0.050 BSC	
H	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	18.97	25.4	0.747	1.000
N	0.20	0.38	0.008	0.015

* See NOTES: 2, 3

F 24-Pin Ceramic Flatpack

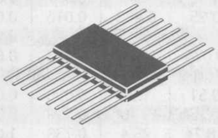


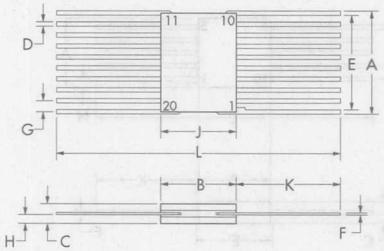


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	1.650	1.900	0.065	0.075
B	0.380	0.480	0.015	0.019
C	0.080	0.150	0.003	0.006
D	—	11.18	—	0.440
E	6.27	6.63	0.247	0.261
G	1.27 BSC		0.050 BSC	
J	0.200	0.380	0.008	0.015
K	6.350	9.400	0.250	0.370
L	0.510	1.020	0.020	0.040
P	0.130	—	0.005	—
R	0.100	—	0.004	—
S	30°	90°	30°	90°

* See NOTES: 2, 12, 13, 14, 15, 16, 17

F 20-Pin Ceramic Flatpack

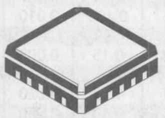


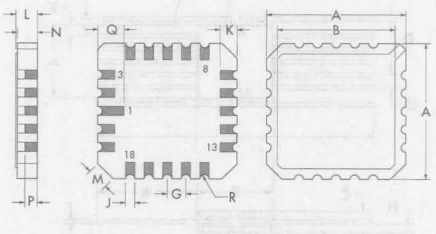


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	—	7.33	—	0.288
B	4.93	5.09	0.194	0.200
C	1.14	1.91	0.045	0.075
D	0.25	0.38	0.010	0.015
E	6.92	7.07	0.272	0.278
F	0.10	0.15	0.004	0.006
G	0.76 TYP		0.030 TYP	
H	0.50	0.64	0.020	0.025
J	—	5.34	—	0.210
K	6.74	7.38	0.265	0.290
L	18.42	19.85	0.724	0.780

* See NOTES: 2, 3, 7, 10, 11

L 20-Pin Ceramic Leadless Chip Carrier (LCC)





DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.64	9.14	0.340	0.360
B	—	8.128	—	0.320
G	1.270 TYP		0.050 TYP	
J	0.635 TYP		0.025 TYP	
K	1.02	1.52	0.040	0.060
L	1.626	2.286	0.064	0.090
M	1.016 TYP		0.040 TYP	
N	1.372	1.68	0.054	0.066
P	—	1.168	—	0.046
Q	1.91	2.41	0.075	0.095
R	0.203R		0.008R	

* See NOTE: 18

* All Notes are located at the end of the Package Outline Section — Page 13-17

PACKAGE DRAWING NOTES

1. These points are reference datums on the molded body and do not include mold flash or protrusions. Mold flash and protrusions shall not exceed 0.15mm (.006") on any side.
2. Lead No.1 is identified by tab on lead or dot on cover.
3. Leads are within 0.13mm (0.005") radius of the true position (TP) at maximum material condition.
4. Dimension "G" determines a zone within which all body and lead irregularities lie.
5. Dimension "E" allows for off-center lid, meniscus and glass overrun.
6. Dimension "N" applies to leads 1, 7, 8, and 14.
7. Dimension "H" is measured at the point of exit of the lead from the body.
8. Dimension "R" applies to all four corners.
9. Dimension "G" is the basic pin spacing between center lines in twelve positions.
10. Dimensions "A" and "J" allow for off-center lid, meniscus, and glass overrun.
11. Dimension "G" eighteen spaces.
12. Dimension "L" shall be measured at the point of exit of the lead from the body.
13. Dimension "D" allows for off-center lid, meniscus and glass overrun.
14. The basic pin spacing is 0.050" (1.27mm) between centerlines. Each pin centerline shall be located within ±0.005" (0.13mm) of its exact longitudinal position relative to pins 1 and 24.
15. Dimension "P" applies to all four corners (leads 3, 10, 15, and 22.)
16. Dimension "R" applies to leads 2, 11, 14, and 23.
17. Dimension "S" applies to leads 1, 2, 11, 12, 13, 14, 23, and 24.
18. All exposed metallized area shall be gold plated 60 micro-inch minimum thickness over nickel plated unless otherwise specified purchase order.

For more information concerning package outlines and dimensions, please contact Linfinity per instructions below.

714-898-8121 Package Information Line

1. Identify your call as a Package Dimension / Package Outline Question.
2. Provide the package type and/or identifier. (e.g., SOIC - DW Package)
3. The receptionist will forward your call to the appropriate Engineer.

IDENTIFICATION OF OFF-SHORE ASSEMBLY LOCATIONS

Linfinity utilizes several off-shore locations to perform assembly and environmental screening operations. This assembly site is identified on the device or unit packaging label according to the following codes:

Country	Preferred Abbreviations	Limited Space Abbreviations
Korea	KOR	A
Philippines	PHIL	S or T
Thailand	THAI	B
U.S.A.	USA	G

LINFINITY MICROELECTRONICS

Package Information

Tube Quantities / Surface-Mount Tape & Reel Information

Tube Quantities

Package Designator	Package Type	Parts per Tube
M	8-pin Plastic DIP	50
N	14-pin Plastic DIP	25
N	16-pin Plastic DIP	25
N	18-pin Plastic DIP	21
N	20-pin Plastic DIP	18
N	24-pin Plastic DIP	16
W	16-pin Plastic Batwing DIP	25
P	3 & 5-pin Plastic TO-220	50
V	3-pin Plastic TO-247	30
Y	8-pin Ceramic DIP	50
J	14-pin Ceramic DIP	25
J	16-pin Ceramic DIP	25
J	18-pin Ceramic DIP	21
IG	3-pin TO-257 (Hermetic TO-220)	50
DM	8-pin Plastic SOIC	100

Package Designator	Package Type	Parts per Tube
D	14-pin Plastic SOIC	55
D	16-pin Plastic SOIC	50
DW	16-pin Plastic SOWB	46
DW	18-pin Plastic SOWB	41
DW	20-pin Plastic SOWB	37
Q	20-pin PLCC	48
Q	28-pin PLCC	39
Q	44-pin PLCC	27
PW	20-pin TSSOP	74
PWP	24-pin TSSOP	62
DP	16-pin Power SOIC	47
DWP	20-pin Power SOWB	37
DWP	28-pin Power SOWB	27
DD	3-pin Surface Mount TO-263AA	50
ST	3-pin SOT-223	78

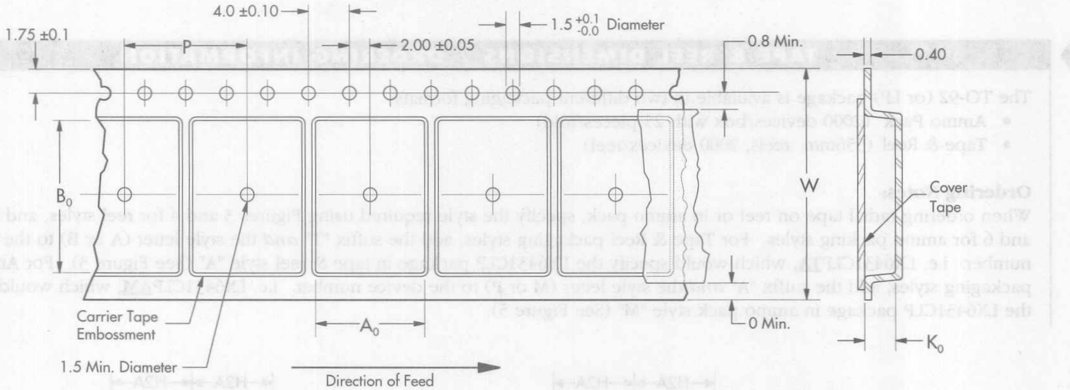
Tape & Reel Dimensions / Quantities

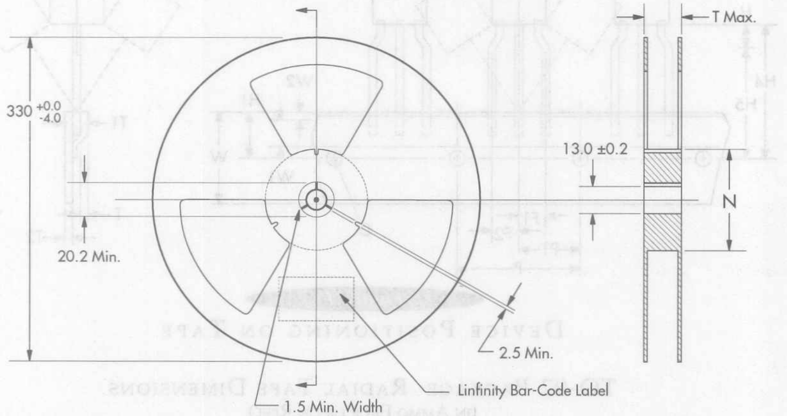
Package Designator	Package Type	Tape Width (W)	Pkg. Pitch (P)	Pocket Width (A_0)	Dim. Length (B_0)	Depth (K_0)	Reel Diameter	Reel Hub Diameter (N)	Parts per Reel
DM	8-pin SOIC	12	8	6.4	5.2	2.1	330	100	2500
D	14-pin SOIC	16	8	6.5	9.0	2.1	330	100	2500
D	16-pin SOIC	16	8	6.5	10.3	2.1	330	100	2500
DW	16-pin SOWB	16	12	10.9	10.7	3.0	330	100	1000
DW	18-pin SOWB	24	12	10.9	12.1	3.0	330	100	1000
DW	20-pin SOWB	24	12	10.9	13.2	3.0	330	100	1000
Q	20-pin PLCC	16	12	10.3	10.3	4.9	330	100	1000
Q	28-pin PLCC	24	16	13.0	13.0	4.9	330	100	750
PW	20-pin TSSOP	16	12	8.2	8.1	2.5	330	100	1500
DB	20-pin SSOP	16	12	8.2	8.1	2.5	330	100	1500
DB	24-pin SSOP	16	12	8.2	9.1	2.5	330	100	1500
DB	28-pin SSOP	16	12	8.2	9.8	2.5	330	100	1000
PK	3-pin SOT-89	12	8	5.1	4.7	2.2	330	50	2500
DP	16-pin SOIC Pwr	16	8	6.5	10.3	2.1	330	100	2500
DWP	20-pin SOWB Pwr	24	12	10.9	13.2	3.0	330	100	1000
DWP	28-pin SOWB Pwr	24	12	10.9	18.3	3.0	330	100	1000
PWP	24-pin TSSOP Pwr	16	12	8.2	9.1	2.5	330	100	1500
DD	3-pin TO-263AA	24	16	10.9	16.0	5.0	330	100	750
ST	3-pin SOT-223	16	12	7	7.5	2.2	330	50	2000

Note: All dimensions are in mm.

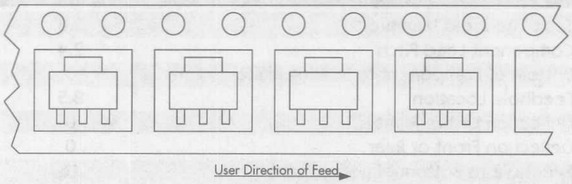
SURFACE-MOUNT TAPE & REEL INFORMATION

Note: All dimensions are in mm.

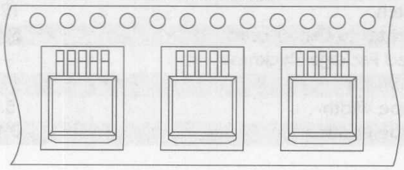




SOT-223 Devices



DD Pack Devices



TAPE & REEL DIMENSIONS / ORDERING INFORMATION

The TO-92 (or LP) package is available in two different packaging formats:

- Ammo Pack (2000 devices/box with 25 pieces/fold)
- Tape & Reel (556mm reels, 2000 devices/reel)

Ordering Notes:
When ordering radial tape on reel or in ammo pack, specify the style required using Figures 3 and 4 for reel styles, and Figures 5 and 6 for ammo packing styles. For Tape & Reel packaging styles, add the suffix "T" *and* the style letter (A or B) to the device number. i.e. LX6431CLP**TA**, which would specify the LX6431CLP package in tape & reel style "A" (See Figure 3). For Ammo Pack packaging styles, add the suffix "A" *and* the style letter (M or P) to the device number. i.e. LX6431CLP**AM**, which would specify the LX6431CLP package in ammo pack style "M" (See Figure 5).

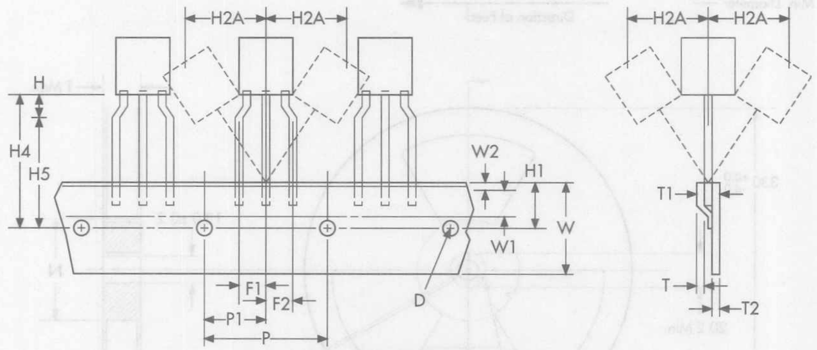


Figure 1

DEVICE POSITIONING ON TAPE

TO-92 PACKAGE RADIAL TAPE DIMENSIONS
(IN AMMO PACK OR ON REEL)

Symbol	Item	Dimensions (mm) Min.	Max.
D	Tape Feedhold Diameter	3.8	4.2
F1, F2	Component Lead Pitch	2.4	2.94
H	Bottom of Component to Seating Plane	0	5.0
H1	Feedhole Location	8.5	9.75
H2A	Deflection Left or Right	0	1.0
H2B	Deflection Front or Rear	0	1.0
H4	Feedhole to Bottom of Component	16	20.5
H5	Feedhole to Seating Plane	15.5	16.5
L1	Lead Wire Enclosure	2.5	—
P	Feedhole Pitch	12.5	12.9
P1	Feedhole Center to Center Lead	5.65	7.05
T1	Overall Taped Package Thickness	—	0.9
W	Carrier Strip Width	17.5	19
W1	Adhesive Tape Width	5.5	6.3
W2	Adhesive Tape Position	0.15	0.5

LINFINITY MICROELECTRONICS

TO-92 (LP) Tape & Reel / Ammo Pack Information

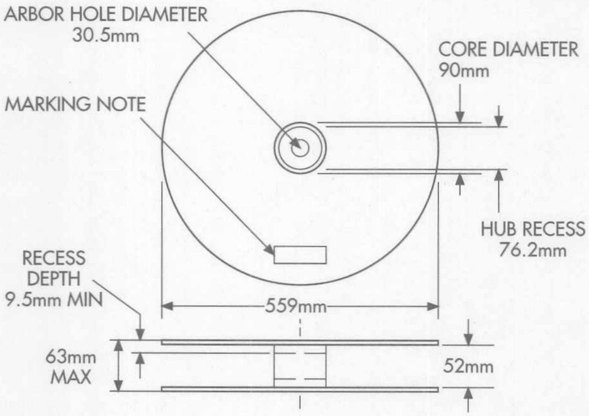
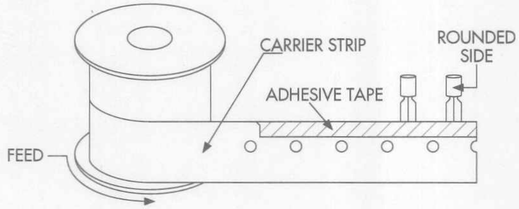


Figure 2

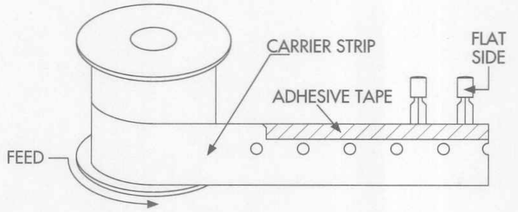
Reel Dimensions



Rounded side of transistor and adhesive tape visible.

Figure 3

Reel Style A



Flat side of transistor and adhesive tape visible.

Figure 4

Reel Style B

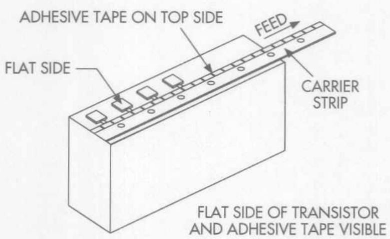


Figure 5

Ammo Pack Style M

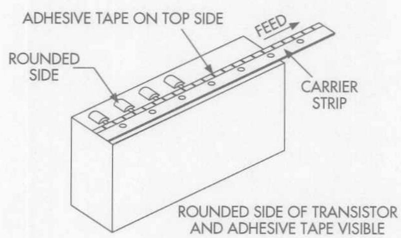


Figure 6

Ammo Pack Style P

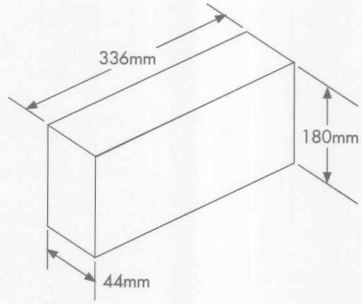


Figure 7

Ammo Pack Box Dimensions

Notes